

TEMPERATURE EFFECT ON DEVELOPMENTAL, RATE LONGEVITY AND PARASITISM OF *Diaeretiella rapae* (M'INTOSH) (HYMENOPTERA- APHELINIDAE)

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ABSTRACT

Temperature- dependent, biological aspects longevity and parasitism of the parasitoid *Diaeretiella rapae* (M'Intosh) was measured at three constant temperatures (15, 25 and 30 °C) using *Brevicoryne brassicae* (L.) . The threshold (t_0) and thermal units (DD's) of different stages of *D. rapae* at different temperatures, 15, 25 and 30 °C., were studied. The rate of development of all stages increased as the temperature increase from 15 to 30 °C. The mean of thermal units recorded 117.9, 88.84 and 222.45 DDs for egg-mummy period, mummy- adult period and adult longevity respectively. Also, the threshold development estimated as 2.4, 1.6 and 3.4 °C for egg- mummy period, mummy- adult period and adult longevity respectively.

INTRODUCTION

The number of species of parasites is speculative, ranging from an estimate of 800,000. The greatest diversity of parasites is found in the Hymenoptera (Uzma, 2010).Therefore, the effective parasitoid should develop very quickly. Species in the subfamily Aphidiinae have rapid larval development and short preoviposition intervals, giving minimum life cycle of 10-15 days (Dank 2000) . However, many parasites, belong to Diptera are rarely representative taxa are also found associated with the Coleoptera, Lepidoptera and Neuroptera. Strepsiptera are true zoological parasites, as they do not kill their hosts (Zamani, 2012; Tazerouni, 2011 and Bauer, *et al.* 2011).

The present work to aim study the effect of temperature degrees on the development, of parasitism and longevity of *D. rapae* at three constant temperatures to evaluate its potential as bio-control agent of *B. brassicae*.

MATERIALS AND METHEDOS

Host aphid source; *B. brassicae* were collected from leaves of the cabbage plant *B. oleraceae* var. capitata, and reared on caged young seedling of its host in a caged pot or on detached young leaves set flat on the bottom of clear plastic jar. The jars were inverted so that the aphids fed in natural position on the under surface of the leaf and change the leaf daily.

Parasitoid source

: A laboratory culture of the parasitoid *D. rapae* started with mummies obtained from the field. Mummified aphids were placed singly in small glass

tubes until the emergence of adult parasitoids which were fed on sugar solution.

To determine the durations of different parasitoid stages *D. rapae*, on the nymphs of *B. brassicae* at three temperatures (15, 25 and 30 °C) , Twenty nymphs of parasitized for each temperature were daily dissected to observe the development of parasitoid stages of *D. rapae*, was (egg – mummy, Mummy –adult and egg –adult, % of emergence and sex ratio).

Colonies of about 100 aphids (mixed adult with nymphs) were reared on fresh plants, into a plastic box (30 cm long, 25 cm high, 10 cm wide) containing an aphid colonies at $25 \pm 5^{\circ}\text{C}$, ten adult parasitoids were introduced for a 24 h stinging period. At the end of the oviposition period, the plants with exposed nymphs were then placed in a thermostat at either 15, 25 and 30°C and $75\pm 5\%$ RH. 10 aphid colonies, each containing 100 aphids, were used for each temperature. Aphids at each temperature treatment were checked four times a day for presence of sedentary and bloated mummies. The mummies were collected in glass vials and returned to the same temperature treatment. All mummies were checked daily until all parasitoids had emerged. Adults were transferred to plastic vials (25 x 10 cm diameter) and kept under the same temperature treatment. Each adult was fed with 15% honey solution. Individual development time was recorded for the period from egg oviposition to mummy formation, and from mummy formation to adult emergence. Longevity was recorded from adult emergence to its death.

The Egg- mummy period (the larval stage) was calculated at each degree of temperature; mummy- adult period (the pupal stage) and adult longevity, under constant temperature.

Linear regression method was applied to calculate the theoretical development threshold as follows: Where the reciprocal for duration time of each stage (y) in days, $1/y$ is multiplied by 100 plotted against temperature (t) in degree centigrade, so the value of the ordinate ($100/y$) represents the average percentage development made by the stage per day at a given temperature. Theoretically the point where the velocity line crosses the temperature axis is the threshold development in degree centigrade (t_0). Thermal units (degree-days) required to complete development of each stage was determined according to (Campbell *et al.* 1974) and (Ramadan, 2008). The degree-days (DD's) were calculated from the following equation:

$$DD = d (t - t_0)$$

Where: DD: thermal units (day-degree)

d: the developmental duration of a given developmental stage at constant temperature (t)

t_0 : threshold temp in degree centigrade.

The statistical analysis (ANOVA) of the obtained data were performed by using SAS program (SAS Institute, 1988).

RESULTS AND DISCUSSION

Data represented in (Table 1) revealed the effect of different temperatures 15, 25 and 30 °C on developmental periods, number of mummies /female, percentage of adults emergence and sex ratio of *Diaeretiella rapae* parasitoid *B. brassicae* on cabbage plants. The result indicated the egg-mummy period was 7.6, 5.8 and 4.6 days at 15, 25 and 30 °C respectively, while the mummy-adult period was 5.4, 4.9 and 2.8 days at 15, 25 and 30 °C respectively. Also, the adult longevity was 15.2, 11.9 and 8.8 days at 15, 25 and 30 °C respectively. Data demonstrated that, the number of mummies /female of *D. rapae* were 9.0, 8.6 and 7.4 adults whereas number of adult /female of *D. rapae* was 8.5, 7.8 and 5.0 adults at 15, 25 and 30 °C respectively. In addition, the result stated that percentage of emergence were 94.4, 90.6 and 67.5 % and the sex ratio of *D. rapae* were 1.8:1, 1.6:1 and 1.5:1 (F: M) at 15, 25 and 30 °C respectively.

Table (1): Effect of different temperatures on some biological aspects of *D. rapae* parasitoid of *B.brassicae*.

Temperature	Biological aspects of <i>D. rapae</i> (days)				Number of mummies /female	Number of adult/fe male	Percentage of emergence %	Sex ratio (F:M)
	Egg-mummy period	Mummy-adult period	Egg- adult period	Adult longevity				
15°C	7.6±0.2	5.4±0.4	13.0±0.34	15.2±0.7	9.0±3.5	8.5±6.5	94.4±4.9	1.8:1
25°C	5.8±0.7	4.9±0.3	10.7±0.5	11.9±0.8	8.6±4.3	7.8±3.5	90.6±3.4	1.6:1
30°C	4.6±0.5	2.8±0.8	7.4±0.67	8.8±0.57	7.4±2.6	5.0±4.7	67.5±3.2	1.5:1
LSD 0.01	1.2	0.93	4.1	3.7	2.03	1.6		

Data in (Table 2) cleared the rate of development, threshold (t_0) and thermal units (DD's) of egg- mummy period of *D. rapae* at different temperature 15, 25 and 30 °C. The result revealed that the Egg- mummy period of *D. rapae* was short with the increase of temperature. Thus, the rate of development egg- mummy increased as well as the temperature increase from 15 to 30°C, the rate of development recorded 13.2, 17.24 and 21.7 % at 15°C, 25°C and 30°C respectively. Also, the threshold of egg- mummy period estimated as 2.4°C and the thermal units were 95.76, 131.08 and 126.96 DDs at 15°C, 25°C and 30°C respectively with an average of 117.9 DDs.

Table (2): Rate of development, threshold (t_0) and thermal units (DD's) of egg- mummy period of *D. rapae* parasitoid of *B. brassicae* .

Temperature	Egg-mummy period	Rate of development%	Threshold development (t_0)	Thermal units (DDs)
15°C	7.6±0.2	13.2	2.4	95.76
25°C	5.8±0.7	17.24		131.08
30°C	4.6±0.5	21.7		126.96
Average	--			117.9

Represented data indicated that the rate of development, threshold (t_0) and thermal units (DD's) of mummy- adult period of *D. rapae* at different temperature 15, 25 and 30 °C. As mention before the mummy- adult period of *D. rapae* was markedly affected by temperature variations. The rate of development was positively depended on temperature which recorded 18.5, 20.4 and 35.7 % at 15°C, 25°C and 30°C respectively. In addition, the estimated threshold of mummy- adult period was 1.6 °C and the thermal units were 72.36, 114.66 and 79.52 DDs at 15°C, 25°C and 30°C respectively with an average of 88.84 DDs. (Table: 3)

Table (3): Rate of development, threshold (t_0) and thermal units (DD's) of mummy- adult period of *D. rapae* parasitoid of *B. brassicae* .

Temperature	Mummy- adult period	Rate of development%	Threshold development (t_0)	Thermal units (DD)
15°C	5.4±0.4	18.5	1.6	72.36
25 °C	4.9±0.3	20.4		114.66
30 °C	2.8±0.8	35.7		79.52
Average	--			88.84

Tabulated data in Table (4) indicated the rate of development, threshold (t_0) and thermal units (DD's) of egg - adult period on of *D. rapae* at different temperature 15, 25 and 30 °C. The obtained data proved that the period of egg - adult stage of *D. rapae* decreased with increasing temperatures from 15 to 30 °C while the rate of development increased as temperature increase which recorded 7.7, 9.34 and 13.5 at 15 , 25 and 30 °C respectively. Also, the result indicated that estimated threshold of egg- adult period was 4.04 °C and the thermal units were 142.48, 224.27 and 192.10 DDs with 15, 25 and 30 °C respectively with an average 186.28 DDs. (Table 4)

Table (4): Rate of development, threshold (t_0) and thermal units (DD's) of egg- adult period of *D. rapae* parasitoid of *B. brassicae*.

Temperature	Egg- adult period	Rate of development%	Threshold development (t_0)	Thermal units (DD)
15°C	13.0±0.34	7.7	4.04	142.48
25 °C	10.7±0.5	9.34		224.27
30 °C	7.4±0.67	13.5		192.104
Average	--			186.28

As shown in (Table 5) data revealed that the rate of development, threshold (t_0) and thermal units (DD's) of adult longevity of *D. rapae* is related to three different temperatures. As other developmental stages, the duration of adult stage decreased with temperature increase while the rate of development was retarded at lower temperature which recorded 6.57, 8.4 and 11.4% at 15°C, 25°C and 30°C respectively. For *D. rapae*, the estimated threshold of adult development was 3.4 °C. Furthermore the thermal units

were 176.32, 257.04 and 234.08 DDs at 15°C, 25°C and 30°C respectively with an average of 222.45 DDs.

Table (5): Rate of development, threshold (t_0) and thermal units (DD's) of adult longevity of *D.rapae* parasitoid of *B. brassicae* .

Temperature	Adult longevity	Rate of development%	Threshold development (t_0)	Thermal units (DD)
15°C	15.2±0.7	6.57	3.4	176.32
25 °C	11.9±0.8	8.4		257.04
30 °C	8.8±0.57	11.4		234.08
Average	--			222.45

These results are in harmony with those recorded by Elliott *et al.* (1995) and Saleh *et al.* (2009) indicated that the developmental periods of different stages of parasitoids *D. rapae* (M'Intosh) shortened as the temperature increased from 10 °C to 28 °C. The studies demonstrated that temperatures determine the effectiveness of a parasitoid as a biological control agent. Also, the number of days required for development decreased with increasing average temperature. Other studies made by Ohta (2012) examined the parasite *Aphidius gifuensis* at four constant rearing temperatures of 15, 20, 25 and 30 °C. The survival rates from egg to adult emergence were more than 80% at all temperatures tested. Host aphid mummification and parasitoid emergence from mummies were observed with very high probabilities of over 80% at all treatments.

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تأثير درجات الحرارة على النمو ومعدل الحياة والتطفل لطفيل *Diaeretiella rapae* (M'Intosh) (Hymenoptera- Aphelinidae)

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تعتبر الحرارة من العوامل المؤثرة على بعض الجوانب البيولوجية لطفيل *D. rapae* التي تم قياسها على ثلاث درجات حرارة ثابتة 15، 25 و 30 م° على من الكرنب الحد الحرج للنمو و الوحدات الحرارية للمراحل البيولوجية المختلفة لطفيل *D. rapae* المتطفل على من نبات الكرنب عند درجات الحرارة المختلفة 15 و 25 و 30 م°. أظهرت النتيجة وجود علاقة طردية بين معدل النمو و درجة الحرارة حيث يزداد معدل النمو في جميع مراحل البيولوجية المختلفة لطفيل *D. rapae* مع زيادة درجة الحرارة 15-30 م° ، سجل متوسط الوحدات الحرارية لفترات تطور مراحل الطفيل *D. rapae* مدة البيضة في المومياء ، مدة الحشرة الكاملة في المومياء وعمر الحشرة الكاملة (117,9 ، 88.84 و 222.45 درجة - يوم) على التوالي. أيضا، سجل الحد الحرج للنمو(صفر النمو البيولوجي) لفترات تطور مراحل الطفيل *D. rapae* مدة البيضة في مومياء ، مدة الحشرة الكاملة في المومياء وعمر الحشرة الكاملة 2.4، 1.6 و 3.4 م° على التوالي.

قام بتحكيم البحث

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