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BIOLOGICAL ASPECTS AND THERMAL REQUIREMENTS OF THE BIRD CHERRY-OAT APHID, *Rhopalosiphum padi* (LINNAEUS), REARED ON WHEAT SEEDLINGS

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ABSTRACT

The bird cherry-oat aphid, *Rhopalosiphum padi* (Linnaeus) was studied at 15, 20 and 25°C constant temperatures. Wheat seedlings were offered for feeding and maintaining the aphid, *R. padi* using the Punctured Ependorf Tube Technique. *R. padi* showed the longest life cycle duration at 15°C as 12.77±1.71days. This duration decreased to 8.36±0.79 and 6.74±0.56 at 20 and 25°C, respectively. The fecundity rate was the lowest (35.41 progenies/female) at 25°C. It was higher at both 15 and 20°C as 50.2 and 53.429 progenies/female, respectively. The longest life span was recorded at 15°C as 49.47±16.43days. This duration decreased to 34.05±6.22 and 19.47±4.16 days at 20°C and 25°C, respectively.

The lower developmental threshold (t_0) for the *R. padi* nymphal instars; first, second, third and fourth were 2.216, 6.958, 3.432 and 0.164°C, respectively. The estimated t_0 values for the life-cycle and generation time were 3.537 and 3.976°C, respectively. The thermal requirements (K) for each nymphal instar; first, second, third and fourth were, life-cycle and generation time were 45.97, 23.43, 30.97, 47.14, 142.56 and 154.15 dgree-days units, respectively.

Keywords: *Rhopalosiphum padi,* biological aspects, heat requirements.

INTRODUCTION

Aphids in the genus *Rhopalosiphum* Koch, are widely distributed in tropical and subtropical regions (Blackman and Eastop, 2000). The bird cherry-oat aphid, *Rhopalosiphum padi* (Linnaeus) is one of the 14 aphid species considered of most agricultural importance worldwide (Blackman and Eastop, 2007). It is an important insect pest of cereals, damaging the hosts both by feeding and by transmitting barley yellow dwarf virus (BYDV) (Stern, 1967 and Kolbe, 1973). This aphid, causes severe damage in cereal-producing countries (Mallott and Davy, 1978).

The development, survival and reproductive potential of *R. padi* were investigated by Abdel-Rahman *et al*. (2002), they found that 24ºC was the optimum temperature. It completes its life cycle on various hosts particularly maize, barley, oats and wheat (Taheri *et al*., 2010).

The present work aimed to study the effect of different constant temperatures on the biological aspects and heat requirements for *R. padi* on wheat plants.

MATERIALS AND METHODS

The bird cherry-oat aphid, *Rhopalosiphum padi* (Linnaeus) collected from a wheat field was reared on wheat seedlings under three different constant temperature (15, 20 and 25^{o}C) and R.H. of 65±10%. The number of aphid replicates were 24, 27 and 22 individuals at each temperature, respectively. Wheat seedlings were offered for feeding and maintaining aphids using the new technique of the Punctured Ependorf Tube Technique (PETT) which described by El-Fatih, (2014).

The newly-born progenies from field-collected mothers were gently transferred separately using a fine hair brush to filter paper discs placed inside clean Petri-dishes containing wheat seedlings germinated in the PETT. These groups of nymphs were monitored daily until death.

The lower developmental threshold (t_0), the thermal constant (K) in Degree-Day Units (DDUs) parameters were estimated for *R. padi* maintained under the three constant temperature regimes, (15, 20 and 25°C).

The biological parameters were estimated by linear regression of the developmental rates over different tested temperatures (Campbell *et al*., 1974).

From the straight line equation (Y= a + b X) the two constants (a+b) and K were determined as follows (Davidson, 1944):

$t_0 = - a / b$ (°C) and $K = 1 / b$ (DDU's) Also $K = T (t - t_0)$

Where t_0 is the developmental threshold °C.

b is the developmental rate slope line.

K is the thermal units in DDU's.

T is the developmental time

t is the existing temperature.

Value of both t_0 and K were expected to be constant for an organism under same environmental and nutritional conditions.

RESULTS AND DISCUSSION

Biological aspects of *R. padi* reared on wheat seedlings:

As illustrated in Table (1), the durations of the first nymphal instar for *Rhopalosiphum padi* (Linnaeus) were 3.63±0.92, 2.55±0.38 and 2.03±0.62 days at the constant temperatures; 15, 20 and 25^{o}C, respectively.

However, the second nymphal durations were 3.20±0.94, 1.62±0.50 and 1.35±0.61 days at the constant temperatures; 15, 20 and 25^{o}C, respectively.

The recorded durations of the third nymphal instar were 2.80±1.08, 1.76±0.44 and 1.47±0.62 days at the constant temperatures; 15, 20 and 25 ^{o}C, respectively.

The recorded durations for the fourth nymphal instar exhibited 3.13 ± 1.55, 2.43 ± 0.60 and 1.88± 0.60 days at 15, 20 and 25^{o}C, respectively. In general, the time needed for the development of nymphal stage decreased with the increase of temperature. The result is similar to that previously

reported by Abd El-Rahman, 1997 and El-Heneidy *et al.,* 2004 for *R. padi* and *S. graminum*.

Table (1): Biological parameters of *R. padi* at three different constant temperatures.

Parameter	Obtained Value		
	Temperature °C		
	15	20	25
First nymphal instar	3.63±0. 92	2.55±0.38	2.03±0.62
Second nymphal instar	3.20 ±0.94	1.62±0.50	1.35±0.61
Third instar	2.80±1.08	1.76±0.44	1.47±0.62
Fourth nymphal instar	3.13±1.55	2.43±0.60	1.88±0.60
Life cycle	12.77±1.71	8.36±0.79	6.74±0.56
Generation time	14.17±1.59	9.45±0.97	7.38±0.49
Life span	49.47±16.43	34.05±6.22	19.47±4.16
Pre-parturation	1.40±1.76	1.10±0.70	0.65±0.49
Parturation	32.07±13.33	19.95±3.58	11.88±3.87
Post-parturation	3.87±4.69	5.10±5.55	0.88±1.41
Female longevity	37.27±15.60	26.24±6.38	13.24±4.21
Fecundity rate (progeny/female)	50.2	53.429	35.412

Rhopalosiphum padi (Linnaeus) recorded the longest life cycle duration (12.77±1.71 days) at 15°C. This duration was decreased to 8.36±0.79 and 6.74±0.56 days at 20 and 25°C, respectively (Table, 1). These findings are going in line with published by Mohamed, 1992. Similar trend was recorded for life cycle of *Rhopalosiphum maidis* (Fitch) which was reared on barley by El-Sheikh *et al*., 2009. Also, Auad *et al.,* 2009 mentioned that development of *R. padi* was faster with increased temperature.

The duration of the longest generation time (14.17 ± 1.59 day) was recorded at 15°C. This duration was decreased to reach 9.45 ± 0.97 and 7.38 ± 0.49 days at 20 and 25°C, respectively (Table, 1). The obtained results are close to those obtained by Feng and Yang (1987) and Auad *et al.,* 2009. The longest life span duration (49.47±16.43days) was obtained at 15 °C and then was decreased to reach 34.05±6.22 and 19.47±4.16 days at 20 and 25°C, respectively (Table, 1). This duration reached 17.4 ± 1.14 d for anholocyclic colony of *R. padi* reared on leaves of barley seedlings at 20ºC (Hutchinson and Bale, 1994) while, it reached 11.94 days for *R. padi* on wheat seedlings at 23 ± 2.5ºC (El-Fatih, 2000).

The longest female longevity (37.27± 15.60 days) was recorded at 15°C. This duration was decreased to reach 26.24±6.38 and 13.24 ± 4.21days at 20 and 25°C. The adult longevity of *R. padi* was lasted for 33.2±0.62 days at 16.5ºC (Mohamed, 1992).

The highest fecundity rate (53.429 progenies/female) was recorded at 20°C and the lowest fecundity rate 35.412 progenies/female was noticed at 25°C (Table, 1). Whereas, it reached 50.2 days at 15°C. Also, Auad *et al.,* 2009 recorded. The highest fecundity rate between 16 and 24 °C. El-Gantiry *et al*. (1999) found that the highest reproductive rate for *S. graminum* was 26.77 individuals/female at 17ºC.

Segonca *et al.* (1994) indicated that the same aphid species, reared under the same climatic conditions, can have different reproductive potentials, which are possibly influenced by other biotic or abiotic factors.

2-Determination of the lower developmental threshold (t_0) and the thermal requirements for *R. padi*:

As illustrated in Table (2) and Fig. (1), the developmental rates for different biological parameters were faster as temperature increased. The result goes in line with that previously mentioned by (Elliott and Kieckefer 1989), (Asin and Pons, 2001), Abdalla (2002) and Auad *et al.,* 2009, they mentioned that temperature influenced the duration of the instars and the nymphal cycle of *R. padi*, the rate of development increased as the temperature increased.

Results obtained by regression equations indicated that a high response between the increased temperature and developmental rate of different studied parameters were noticed. Out of these equations, the (t_0) value and the (K) value were estimated.

The (t_0) values for the nymphal instars; first, second, third and fourth were 2.216446, 6.957662, 3.432193 and 0.164116^{o}C, respectively. The t_0 value was estimated also, for the life-cycle and generation time of *R. padi* which being 3.537458 days and 3.976148 days, respectively.

The lower threshold (t_0) of *R. padi* for the first, second, third, and fourth nymphal instars and the life-cycle were estimated as 4.2, 4.7, 3.9, 4.6, and 4.4 ^{o}C on wheat, and 4.6, 5.1, 4.6, 5.6, and 5^{o}C on barley, respectively Abdalla, 2002.

The estimated (K) values in this study for nymphal instars; first, second, third, and fourth nymphal instars, the life-cycle and generation time were 45.97188, 23.43949, 30.97345, 47.14734, 142.5666 and 154.1546, respectively. Abdel-Rahman, 2002 mentioned that the thermal units needed for *R. padi* to complete its development were about 92.32 day-degrees using 8.89 ^{0}C as base temperature (t_o). While Auad *et al.,* 2009 recorded them as 39.84, 35.46, 33.89, 33.78 and 149.2 for the first, second, third, and fourth nymphal instars and the life-cycle respectively.

In general, results obtained by regression equations indicated that were a high response between the increased temperature and developmental rate of different studied parameters.

Table (2): Results of developmental rates and thresholds for different biological parameters of *R. padi* and their thermal requirements and regression values.

Tested parameter		Developmental rates (1/D) Temp. degree °C			Regression values (Y=a+bx)			Developmental threshold (t_0) °C	Thermal requirements (K) (Degree-Days)
		15	20	25	a	b	R^2		
Nymphal instars	First	0.2752	0.3925	0.4927	-0.04821	0.0217	0.999	2.216446	45.97188
	Second	0.3125	0.61764	0.7391	-0.29684	0.042663	0.9829	6.957662	23.43949
	Third	0.3571	0.5675	0.68	-0.11081	0.032286	0.997013	3.432193	30.97345
	Fourth	0.3191	0.4117	0.5312	-0.00348	0.02121	0.999226	0.164116	47.14734
Life cycle		0.0783	0.11961	0.1484	-0.02481	0.007014	0.997611	3.537458	142.5666
Generation time		0.0705	0.1057	0.1354	-0.02579	0.006487	0.999499	3.976148	154.1546

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الظواهر البيولوجية والاحتياجات الحرارية لمنّ الشوفان المربى على نباتات القمح

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تم دراسة الظواهر البيولوجية والاحتياجات الحرارية لحشرة من الشوفان تحت ظروف المعمل على بادرات القمح على ثلاث درجات حرارة ثابتة هي ١٥، ٢٠ و ٢٥ م.

كانت اطول فترة دورة حياة تم تسجيلها هى ١٢.٧٧±١.٧١ يوم عند درجة ١٥ م. بينما وصلت هذه الفترة الى ٨.٣٦±٠.٧٩ و٦.٧٤ ±٠.٥٦ يوما عند درجة حرارة ٢٠ و ٢٥م على الترتيب.

تم تسجيل اطول فترة جيل (١٤.١٧ ± ١.٥٩ يوم) عند درجة حرارة ١٥م، ثم انخفضت هذه الفترة لتصل الى ٨.٤٥±٠.٩٧ و ٧.٣٨±٠.٤٩ يوم مع زيادة درجة الحرارة من ٢٠ إلى ٢٥ م على التوالى. سجل أقل معدل للخصوبة (٣٥.٤١٢ ذرية / أنثى) عند درجة حرارة ٢٥ م وكان اعلى معدل لها (٥٣.٤٢٩ ذرية / أنثى) عند درجة حرارة ٢٠ م بينما كانت ٥٠.٢ ذرية / أنثى عند ١٥ م. سجلت أقصى فترة لحدود الحياة للإناث (٤٩.٤٧±١٦.٤٣ يوم) عند درجة حرارة ١٥م، ثم انخفضت هذه الفترة لتصل إلى٣٤.٠٥ ±٦.٢٢ و ١٩.٤٧ ± ٤.١٦ يوم عند درجات حرارة ٢٠ و ٢٥ م، على الترتيب.

تأثرت معدلات التطور لبعض القياسات (فترات الاعمار الحورية- مدة دورة الحياة- فترة الجيل) لحشرة من الشوفان على بادرات القمح بدرجات الحرارة التي تم التعرض لها حيث كانت هذه الفترات أقصر و معدلات التطور أسرع مع زيادة درجة الحرارة، كما أوضحت معادلات الارتباط أن هناك استجابة عالية بين زيادة الحرارة ومعدل التطور لكثير من القياسات التي تم دراستها. وأوضحت تلك المعادلات أن الحد الحرج للنمو Developmental threshold (t.) للأعمار الحورية (أولى- ثانية- ثالثة- رابعة) كانت ٢.٢١٦، ٦.٩٥٨، ٣.٤٣٢ و ٠.١٦٤ م على الترتيب. تم أيضا تقدير (t.) لدورة الحياة وفترة الجيل حيث بلغت ٣.٥٣٧ و٣.٩٧٦م على الترتيب. كما كانت الاحتياجات الحرارية (K) لكل عمر من أعمار الحورية وأيضا لدورة الحياة وفترة الجيل هى ٤٥.٩٧٢، ٢٣.٤٣٩، ٣٠.٩٧٣، ٤٧.١٤٧، ١٤٢.٥٦٦ و ١٥٤.١٥٥ وحدة حرارية على الترتيب.