EFFECT OF TEMPERATURE ON THE BIOLOGY OF TUBEROLACHNUS SALIGNUS (GMELIN) (STERNORRHYNCHA: APHIDIDAE) ON (SALIX ALBA)

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ABSTRACT

The development time, survivoship and reproduction of Tuberolachnus salignus (Gmelin)(Lachninae: Lachnini) were studied on Salix alba at five constant temperatures (17.5°C, 20°C, 22.5°C, 25°C and 27.5°C). The developmental time of immature stages ranged from 17.00 days at 17.5°C to 12.21 days at 25°C on Salix alba. The total percentage of survivorship of immature stages varied from 50% and 70% 17.5°C -20°C on S. alba. The largest r_m value occurred with 0.2540 at 20°C on S. alba. The mean generation time of the population ranged from 13.595 days at 22.5°C to 19.60 days at 17.5°C on S. alba. The optimal temperature for Tuberolachnus salignus was 20°C.

KEY WORDS: Tuberolachnus salignus, Developmental time, Survival, Life table

INTRODUCTION

The giant willow aphid, Tuberolachnus salignus Gmelin (Lachninae: Lachnini) is the largest of the over 120 species of aphid that feed on willows (Salix spp.) and longest-lived aphids ever recorded [6,16,9]. This species has an almost cosmopolitan distribution [9] and is present in Turkey [8,21,2]. It occurs visibly on host trees from mid-summer until January or February. As this species is apomictic and cannot generate an egg stage by sexual reproduction [5].

Temperature is the most important abiotic factor affecting development and reproduction of aphids, geographically separated populations of aphid may differ with respect to the influence of temperature on development and population growth [7]. Temperature influences both aphid development and mortality and is a fundamental feature of its life history [19,20]. Temperature influences both aphid development and mortality rates therefore, knowledge of the effects of temperature on the biological parameters is essential to investigate aphid population dynamics.

The present study was designed to provide data on the developmental rate and fecundity of T. salignus at different constant temperatures than might be used for developing control models.

MATERIAL AND METHODS

Aphid and plant source

The T. salignus clone used was originally collected from Salix alba in Tekirdağ, Turkey. The aphids were raised on potted, growing willow trees maintained a climatic room held at 25±1°C, a relative humidity 65±5 %, and a light regime (16 h light; 8 h dark).

Development and survival

Nymphal development duration was estimated on Salix alba grown at five different temperatures (17.5±1, 20±1, 22.5±1, 25±1 and 27.5±1 °C, ambient temperature) under conditions of controlled day length (16 h light; 8 h dark).

For each of 40 replicates per temperature on Salix alba, apterous adult were placed on an isolated cutting of the willow species. Observations were made until the adult established and each twig hosted one progeny the adults removed. The time on each twig underwent ecdysis at each instar change was noted. The nymph and adult on each Petri dish were checked daily under stereoscopic microscope and their survival recorded at the constant temperatures.

Adult longevity and reproduction

When the immature nymphs become adults, they were observed daily for reproduction and survival and all new-born nymphs were removed from each Petri dishes after counting and these observations continued until the mature aphid died at all constant temperature regimes. Developmental times for each nymphal instar, duration of adult pre-reproductive, reproductive and post-reproductive periods, lifetime fecundity and average daily reproduction were calculated for each aphid. Forty aphids were tested for each temperature degree conditions.

Data analyses and statistics

Differences in nymphal development times, adult life span, fecundity, and daily reproduction at five constant temperatures were analyzed using ANOVA and treatment differences were determined by Duncan's Multiple Range Tests.

Effect of different temperatures on biology of the giant willow aphid were assessed by constructing a life table, using age specific survival rates (l_x) and fecundity (m_x) for each age interval (x) per day. The intrinsic rate of increase r_m was calculated by iteratively solving the equation $\sum e^{-rx} l_x m_x = 1$, where the age-specific survival rate (l_x) is the proportion of individuals in the original cohort alive at age x, and the age-specific fecundity (m_x) is the mean number of female progeny produced per female alive in the age-interval x. The net reproductive rate, $R_{0=}\sum l_x m_x$, were also calculated [4].

RESULTS

Development and survival

The developmental times for the immature stages at five constant temperatures are presented on Salix alba in Table 1. The developmental time of T. salignus decreased significantly, as constant temperature increased on Salix alba (Table1, $P<0.05$). The constant temperature of 27.5 °C was lethal of T. salignus. Total nymphal development time ranged from 12.21 d at 25°C to 17.0 d at17.5 °C on Salix alba (Table 1).

Survivoship rate for immature stages differed significantly with five constant temperatures on Salix alba (Table 2). The high temperature at 27.5 °C had a detrimental effect on the survivorship of immature stages (Table2). The highest mortality occurred at 17.5 °C.

Adult longevity and reproduction

Temperature affected adult longevity and fecundity significantly on S. alba (Table 3). The mean longevity of adult females varied from 5.60 d at 17.5 °C to 19.85 d at 20° on S. alba. The average nymph production of female (offspring per female) reached a maximum of 56.97 nymphs per female (20 °C) and lowest of 17.54 nymphs per female (17.5 °C) on S. alba

Table 1. Mean duration, ±SE, in days of nymphal instars, total nymphal duration of Tuberolachnus salignus on Salix alba at five reared at five different temperatures.

	Duration in days / Temperature (°C)	First instar	Second instar	Third instar	Fourth instar	Total nymphal duration
Salix alba	17.5	5.00±0.94c	3.56±0.85d	4.00±096b	4.95±1.15c	17.0±2.27c
	20	4.40±0.49b	2.82±0.39c	4.00±0.54b	4.11±0.57b	15.29±0.59b
	22.5	4.51±0.84b	1.75±0.76a	2.79±0.42a	3.35±049a	12.47±0.75a
	25	3.79±0.41a	2.41±0.49b	2.81±0.54a	3.11±0.41a	12.21±0.74a
	27.5	4.60±1.33bc	3.33±1.09d	4.24±1.68b	4.67±1.58bc	15.00±1.0b

Means within the same column sharing the same letter are not significantly differ (α =0.05, Duncan multiple range test)

Table 2 Survival (percentage) of immature stages of Tuberolachnus salignus on Salix alba and at five different temperatures

Temperature (°C)	Salix alba				
	First instar	Second instar	Third instar	Fourth instar	Total nymphal duration
17.5	70	96	96	74	50
20	75	93	93	93	70
22.5	93	86	88	82	53
25	85	100	91	87	68
27.5	75	80	71	18	8

Intrinsic rate of increase (r_m), net reproduction rate (R_0) and generation time (T_0) were calculated for the aphid on S. alba at five different temperatures (Table 4). The highest (r_m) occurred with 0.2540 on S. alba at 20°C (Table 4). Net reproductive rate (female offspring per adult female), R_0 was highest at 20°C. Increasing temperatures resulted in shorter generation times.

DISCUSSION

Temperature is a key biotic factor that regulates the insect population dynamics, rates of development, reproduction, mortality, survival and seasonal occurrence of aphids [7,11,12, 13, 17]. Although insect are not subjected to constant temperatures is nature, controlled laboratory studies can provide a valuable insight into the population dynamics of aphids [19]. Our results reported here clearly show the effects of temperature on the developmental time, nymphal mortality rate, longevity and fecundity of T. salignus.

Rearing aphids at the highest experimental temperature (27.5°C) had a detrimental effect on the survivorship of immature stages (Table 2). The high temperature examined here (25°C) decreased their development time (Table 1), in that they developed fastest and had a 68% survival rate on S. alba. Similar observation was also reported by Collins et al. [10]for the T. salignus on Salix viminalis.

The development time at all constant temperatures examined here forth instars showed a delay in development namely the second and third instars on the S. alba (Table 1). This may be because of important physiological changes that must occur during metamorphosis from the fourth-instar to adult stage. This observation was also reported by Rhopalosiphum padi (L.) Özder [14], the English grain aphid, Sitobion avenae (Fabricus) Özder [15] and Aphis punicae (Passerini) Bayhan et al. [3]. Similar results have been reported for the fifth instar of the potato leafhopper, Empoasca fabae (Harris) for the other species of Homoptera Simonet and Pienkowski[18].

The intrinsic rate of natural increase (r_m) is a good indicator of the temperature at which the growth of a population is most favorable, because it reflects the overall effect of temperature on the development, reproduction and survival characteristics of a population. The intrinsic rate of increase (r_m) summarizes the physiological qualities of an animal relation to capacity to increase [1].

The population kept at 20°C had the highest r_m value among all temperatures on Salix alba (r_m = 0.2540),

Table 3 Mean ± SE fecundity and longevity of female T. salignus on Salix alba and at five different temperatures

	Temperature (˚C)	Longevity of female(days)	No. progeny/female
Salix alba	17.5	5.60±2.56a	17.54±8.50a
	20	19.85±10.02c	56.97±22.62c
	22.5	6.60±2.23a	22.21±10.21a
	25	12.69±7.81b	35.77±22.89b
	27.5	-	-

Means within the same column sharing the same letter are not significantly differ (α =0.05, Duncan multiple range test)

Table 4. Life table parameters of Tuberolachnus salignus on Salix alba at five different temperatures

	Salix alba		
Temperature (°C)	Generation time (T_0)	Reproduction rate(R_0)	Intrinsic rate of increase(r_m)
17.5	19.60	25.97	0.1661
20	16.83	67.30	0.2540
22.5	13.59	29.52	0.2494
25	14.46	21.18	0.2111

because higher survivorship of immature stage and greater progeny production.

The results of this study demonstrate that different temperatures influence population growth rate and fecundity of the aphid T. salignus. We can conclude that T. salignus has greatest pest potential on S. alba under springtime conditions when temperature are most favorable for aphid development in Trakya region of Turkey.

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