Persian J. Acarol., 15(1): 150101.

Research Article https://biotaxa.org/pja https://doi.org/10.22073/pja.v15i1.85761

Effect of temperature on biological parameters of *Eutetranychus africanus* (Tücker) (Acari: Tetranychidae) on white frangipani

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Received: 14 June, 2025

Accepted: 06 October, 2025

Published: 15 January, 2026

Subject Editor: *A. Farazmand*

ABSTRACT

This study investigates the effects of temperature on the development, survival, and reproduction of *Eutetranychus africanus* (Tücker) (Acari: Tetranychidae) reared on White frangipani (*Plumeria alba* L.: Apocynaceae) under laboratory conditions. Development, survivorship, and reproduction of this mite were studied on units made of detached leaves of *P. alba*, at three constant temperatures (20, 25, and 30 ± 2 °C), relative humidity (70 ± 5% RH), and photoperiod (16L: 8D). Mites completed their development and reproduced at all three tested temperatures. Developmental time, oviposition period, adult longevity, and life span decreased as temperature increased, although daily oviposition rate and fecundity increased. The results indicated that while *E. africanus* develops across a wide temperature range, 30 °C has the highest intrinsic rate of increase (r), the net reproductive rate (R_0), and the shortest time for population doubling (*DT*). The gross reproductive rate (*GRR*) reached the highest value at 30 °C as well. This study might be a significant step toward funding the future establishment of effective mite control.

KEYWORDS

African red mite, development, Egypt, life history, *Plumeria alba*, survivorship

CITE: Abo-Shnaf, R. & Elhalawany, A.S. (2025) Effect of temperature on biological parameters of *Eutetranychus africanus* (Tücker) (Acari: Tetranychidae) on white frangipani. *Persian Journal of Acarology*, 15(1): 150101. https://doi.org/10.22073/pja.v15i1.85761

INTRODUCTION

Tetranychids are plant feeders, and several species cause considerable injury to crops. They infest field and truck crops, fruit trees, ornamentals, wild plants, and weeds (Krantz 1975; Zaher 1984). Representative species of *Eutetranychus* Banks are found worldwide, attacking primarily trees and shrubs. The African red mite, *Eutetranychus africanus* (Tücker) (Tetranychidae) has been mentioned as a serious pest of several hosts of economic importance, including citrus, grape, eggplant, cucumber, squash, peach, papaya, loquat, and *Plumeria* spp. (Jeppson *et al.* 1975). This species has been recorded in multiple countries, including Egypt (Lin *et al.* 2020), and is known to infest 77 plant species across 23 families (Bolland *et al.* 1998; Ohno *et al.* 2011; Hassan *et al.* 2013; Quimio *et al.* 2013; Migeon 2015; Migeon and Dorkeld 2024). In Upper Egypt, *E. africanus* has been documented on various hosts such as eggplant, cotton, fig, apple, and orange (Attiah 1967).

Studies on the biology of *Eutetranychus* species have been conducted by several authors (i.e., Siddig and El-Badry 1971; Banu and ChannaBasavanna 1972; Rasmy 1978; Dhooria 1982; Afifi *et al.* 1988; Childers *et al.* 1991; Badii *et al.* 2003; Barbosa *et al.* 2004; Imani and Shishehbor 2009; Abd El-Wahab *et*

al. 2010, Abd-El-Wahed *et al.* 2012; Elhalawany 2019; Metwally *et al.* 2019; Lin *et al.* 2020; Yalçin *et al.* 2022). The biology and host range of *Eutetranychus orientalis* (Klein) has received more attention in Egypt (Salman 1983; Hafez *et al.* 1984) than *E. africanus* in different countries.

White frangipani (*Plumeria alba* L.: Apocynaceae) is an important plant for medicinal usage as it is used to treat ulcers, herpes, scabies, and hemostasis (Radha *et al.* 2008). It is severely damaged by *E. africanus* which attacks the leaves.

Temperature is a crucial factor influencing the development, survival, and reproduction of insect and mite pests. Understanding how temperature affects these biological parameters is essential for predicting population dynamics and developing effective pest management strategies (Birch 1948; Carey 1993). The age-stage, two-sex life table provides a comprehensive framework for analyzing the demographic characteristics of pests, considering variations in development rates among individuals (Huang and Chi 2013). Life table studies help estimate key parameters such as developmental duration, survival rate, fecundity, and population growth potential, which are vital for designing sustainable pest control strategies (Southwood and Henderson 2000; Chi and Su 2006).

Studies on the biology of *Eutetranychus* species have been conducted by several authors, focusing on their development, reproduction, and host plant interactions. However, limited research has specifically examined the effect of temperature on *E. africanus*, despite its crucial role in determining developmental rates, survival, and reproductive success. Temperature influences the population dynamics of mites, affecting their feeding activity, infestation levels, and overall damage to host plants. Understanding these temperature-dependent biological traits is essential for predicting outbreaks and implementing effective pest management strategies. Therefore, this study aims to address this gap by determining the influence of different temperatures on the development, survival, and reproduction of *E. africanus* using the age-stage, two-sex life table theory. These findings will contribute to a better understanding of the population dynamics of *E. africanus* and provide insights into its management in agroecosystems.

MATERIAL AND METHODS

Colony maintenance

A stock colony of *E. africanus* was maintained in the laboratory on the upper side of white frangipani leaves in a room at 25 °C and 70 ± 5% RH. The leaves were placed on a piece of cotton pad maintained permanently wet in Petri dishes (12 cm in diameter) by periodic addition of distilled water.

Experimental design

Forty newly hatched larvae were individually placed on fresh *P. alba* leaf discs (2.5 cm in diameter) with the upper surface facing up. The leaf discs were positioned on a cotton pad within Petri dishes (12 cm in diameter) and maintained in a moist environment by the periodic addition of distilled water. The margins of the discs were covered by a band of cotton wool to keep the disc turgid and to prevent mites from escaping. Leaves were replaced every five days. Experiments were carried out at three constant temperatures (20, 25, and 30 ± 2 °C), 70 ± 5% RH, and a photoperiod of 16L: 8D. Selecting those temperatures is to fit the temperature range (18–27 °C) in which white frangipani is grown throughout their active growing season. Mites were examined twice a day (at 07:00 and 19:00) to determine the duration of each stage and the duration of each adult phase. During the developmental period, mortalities of different stages and sex ratio of progeny were specified. Oviposition results for females was recorded daily for each female.

Statistical analysis

The effect of temperature on developmental times, survival rate, oviposition period, longevity, and fecundity was evaluated using the statistical package of SAS (SAS Institute 2003). Differences between means were separated by Tukey's honestly significant difference test (Tukey's HSD test at $\alpha = 0.05$).

Life table parameters were calculated according to the age-stage, two-sex life table theory (Chi and

Liu 1985) and the method by Chi (1988) using the TWOSEX-MSChart program (Chi 2018).

The net reproductive rate (R_0) represents the mean number of female offspring that an individual can produce during its lifetime and was calculated as:

$$R_0 = \sum_{x=0}^{\omega}\sum_{j=1}^{k} S_{xj} f_{xj}$$

The mean generation time (T) was calculated as:

$$T = \frac{InR0}{r}$$

The intrinsic rate of increase (r) was calculated as:

$$\sum_{x=0}^{\infty} e^{-r\,(x+1)lxmx=1}$$

with age indexed from 0 to ω (maximum age).

The doubling time (DT) was calculated as:

$$DT = \frac{In2}{r}$$

The gross reproductive rate (GRR) is calculated as:

$$GRR = \sum mx$$

The finite rate of increase (λ) was calculated as:

$$\lambda = e^{r}$$

The age-specific survival rate (l_{xj}) was calculated as:

$$lx = \sum_{j=1}^{m} S_{xj}$$

where m is the number of stages.

The age-specific fecundity (m_x) was calculated as:

$$m_x = \frac{\sum_{j=1}^{m} S_{xj} f_{xj}}{\sum_{j=1}^{m} S_{xj}}$$

Age-stage-specific life expectancy (e_{xj}) is the time that an individual of age x and stage j is expected to be alive. This parameter was calculated according to the method by Chi and Su (2006):

$$e_{xj} = \sum_{i=x}^{n}\sum_{j=y}^{m} S'_{ij}$$

where S'_{ij} is the probability that an individual of age x and stage j will survive to age i and stage j.

The age-stage specific reproductive value (v_{xj}) defined as the contribution of individuals of age x and stage j to the future population (Fisher 1930) and calculated according to Huang and Chi (2011) and Tuan *et al.* (2014a, b) as:

$$v_{xj} = \frac{e^{r(x+1)}}{S_{xy}} \sum_{i=x}^{n} e^{-r(i+1)} \sum_{j=y}^{m} S'_{ij} f_{ij}$$

The age-stage survival rate (s_{xj}; where x = age and j = stage), which is the probability that a newly laid egg will survive to age x and stage j; and the age-stage fecundity (f_{xj}) gives the number of hatched eggs produced by adult females at age x. The means, standard errors, and variances of the population parameters were estimated using the bootstrap technique (100,000 samples), which is included in the TWOSEX-MSChart program of Chi (2018; Ver. 5/7/2024). The means were compared by the Paired Bootstrap test based on the confidence interval of difference ($P < 0.05$) (Huang and Chi 2013). Excel 2010 was used to create s_{xj}, l_x, m_x, $l_x m_x$, v_{xj} and e_{xj} curves.

RESULTS

Developmental time and oviposition

The survivorship of eggs at the three constant temperatures was 100%. The duration of each immature stage was slightly shorter for males than females (Table 1). The duration of each stage was progressively shorter with increasing temperature; life cycle ranged from 18.6 days at 20 °C to 8.8 days at 30 °C for females ($F = 442.2$, $P < 0.0001$) and from 17.4 to 8.6 days for males ($F = 155.8$, $P < 0.0001$).

Significant differences for each stage were found between the mean developmental times at the different temperatures. The shortest female incubation period of larval, protonymphal, deutonymphal stages, total immature stages, and lifecycle were recorded at 30 °C, while the longest ones were recorded at 20 °C (Table 1).

Table 1. Duration of different life stages (Mean ± SE) and fecundity of the female of *Eutetranychus africanus* on *Plumeria alba* leaves at different constant temperatures.

		Female			Male		
Temperature (°C)		**20**	**25**	**30**	**20**	**25**	**30**
No. individuals tested		**20**	**18**	**19**	**10**	**13**	**12**
Egg		5.5 ± 0.5a	4.3 ± 0.5b	2.8 ± 0.5c	4.9 ± 0.5a	4.0 ± 0.5b	2.7 ± 0.5c
Larva	A[1]	1.7 ± 0.3a	1.2 ± 0.3b	0.7 ± 0.2c	1.6 ± 0.3a	1.1 ± 0.4b	0.6 ± 0.3c
	Q[2]	1.6 ± 0.4a	1.0 ± 0.3b	0.7 ± 0.1c	1.5 ± 0.3a	0.8 ± 0.2b	0.6 ± 0.3b
Protonymph	A	2.0 ± 0.2a	1.6 ± 0.3b	1.3 ± 0.3b	1.9 ± 0.4a	1.5 ± 0.3b	1.3 ± 0.3b
	Q	2.8 ± 0.4a	1.5 ± 0.3b	1.1 ± 0.3b	2.7 ± 0.1a	1.4 ± 0.3b	1.1 ± 0.2b
Deutonymph	A	2.8 ± 0.2a	1.7 ± 0.1b	1.3 ± 0.2c	2.6 ± 0.3a	1.5 ± 0.3b	1.2 ± 0.2b
	Q	2.2 ± 0.3a	1.6 ± 0.3b	1.1 ± 0.2b	2.2 ± 0.3a	1.5 ± 0.3b	1.1 ± 0.3b
Immature stages		13.1 ± 0.4a	8.6 ± 0.5b	6.0 ± 0.5c	12.4 ± 0.3a	7.8 ± 0.6b	5.8 ± 0.7c
Life cycle		18.6 ± 0.6a	12.9 ± 0.5b	8.8 ± 0.7c	17.4 ± 0.7a	11.8 ± 0.6b	8.6 ± 0.4c
APOP		1.7 ± 0.4a	1.6 ± 0.5a	1.5 ± 0.5a			
TPOP		20.3 ± 0.4a	14.5 ± 0.5b	10.3 ± 0.7c			
Oviposition		22.0 ± 0.5a	11.4 ± 0.7b	5.3 ± 0.5c			
Post-oviposition		1.8 ± 0.4a	1.6 ± 0.4ab	1.5 ± 0.5a			
Longevity		25.5 ± 0.7a	14.6 ± 0.6b	8.3 ± 0.7c	21.7 ± 0.7a	12.8 ± 0.8b	6.2 ± 0.6c
Total lifespan		44.1 ± 0.6a	27.5 ± 0.7b	17.1 ± 0.8c	39.1 ± 0.5a	24.6 ± 0.6b	14.7 ± 0.7c
Fecundity		18.1 ± 0.8c	20.7 ± 0.9b	28.3 ± 0.9a			
Eggs/ female/ day		0.8 ± 0.1c	1.8 ± 0.1b	5.4 ± 0.4a			

[1]Active; [2]Quiescent; APOP = Adult pre-oviposition period; TPOP = Total pre-oviposition period; means followed by the same letters in the same row are not significantly different according to the paired bootstrap test ($P < 0.05$).

No significant differences were observed for duration of pre-oviposition and post-oviposition at the different temperatures (Table 1), probably because of the short durations of those phases at all temperatures and the fact that observations were only done twice a day. Similarly to what was observed for the duration of immature development, duration of the oviposition phase was also progressively shorter with increasing temperature, ranging from 22.0 days at 20 °C to 5.3 days at 30 °C ($F = 746.8$, $P < 0.0001$). Consequently, for females, the same pattern was observed for longevity, which ranged from 25.5 days at 20 °C to 8.3 days at 30 °C ($F = 880.8$, $P < 0.0001$), and to life span, which ranged from 44.1 days at 20 °C to 17.1 days at 30 °C ($F = 1479.2$, $P < 0.0001$). Also, for males, longevity and life span decreased with increasing temperature, *i.e.*, respectively from 21.7 to 6.2 and from 39.1 to 14.7 days at same temperatures ($F = 395.5$, $P < 0.0001$; $F = 592.0$, $P < 0.0001$).

Daily oviposition rate (eggs/female/day) and fecundity (eggs/female) increased progressively with increasing temperature (Table 1), the first ranging from 0.8 to 5.4 eggs/female/day at 20 and 30 °C ($F = 505.0$, $P < 0.0001$) and the second from 18.1 to 28.3 eggs at 20 and 30 °C, respectively ($F = 173.8$, $P < 0.0001$).

Survival and fecundity

The survivorship of the immature phase and the sex ratio were very similar at the different temperatures. The probability that a newly laid egg survived to adult stage was similar at the three temperatures (0.67 for the females and 0.33 for the males). Male adults emerged earlier and survived shorter than females at all temperatures (Fig. 1).

Age-specific survivorship and age-stage-specific fecundity

The age-specific survival rate (l_x), age-specific fecundity (m_x), and age-stage-specific fecundity (f_{xj}) of *E. africanus* were greatly influenced by temperature (Fig. 2). The age-specific survival rate was highest at 20 °C and decreased as the temperature increased. The maximum number of eggs was produced at 30 °C (day 10: 3.5 eggs/female/day), and the lowest value was obtained at 20 °C (day 24: 0.77 eggs/female/day). The age-specific fecundity (f_{xj}) reached peak on the 9th day at 30 °C (6.23 eggs), on the 17th day at 25 °C (2.05 eggs), and on the 24th day at 20 °C (1.15 eggs), and decreased gradually, thereafter. At those temperatures, the first oviposition occurred on days 16, 11, and 7 at 20, 25, and 30 °C, respectively.

Age-stage specific reproductive value

The highest age-stage specific reproductive value (v_{xj}) for females was 20.71 on the 7th day at 30 °C, 12.41 on the 11th day at 25 °C, and 9.51 on the 16th day at 20 °C (Fig. 3). This suggests that in comparison to other ages, females aged 7, 11, and 16 days contributed the most to the population when reared at the specified temperature.

Age-stage life expectancy

Based on the age-stage survival rate, the age-stage life expectancy (e_{xj}) of *E. africanus* decreased with aging. The life expectancy of female adults was much higher than male adults and gradually declined with aging at all temperatures. The highest life expectancy of the female was 28.7, 17.05, and 10 days at 20, 25, and 30 °C, respectively. The life expectancy for males was highest (24.2 days) at 20 °C and lowest (7.8 days) at 30 °C (Fig. 4).

Table 2. Population parameters of *Eutetranychus africanus* at different constant temperatures.

Temperature (°C)	**20**	**25**	**30**
Number of females tested	**20**	**18**	**19**
Gross reproductive rate (*GRR*)	12.68 ± 1.48b	14.13 ± 1.75ab	19.88 ± 2.45a
Net reproductive rate (R_0)	12.03 ± 1.56b	13.8 ± 1.79ab	18.86 ± 2.45a
Intrinsic rate of increase (r)	0.089 ± 0.0052c	0.143 ± 0.0079b	0.262 ± 0.0014a
Finite rate of increase (λ)	1.09 ± 0.0057c	1.15 ± 0.0091b	1.30 ± 0.0018a
Mean generation time (T)	27.68 ± 0.45a	18.23 ± 0.26b	11.17 ± 0.31c
Doubling generation (*DT*)	7.71 ± 0.47a	4.81 ± 0.27b	2.63 ± 0.14c

Means followed by the same letters in the same row are not significantly different according to the paired bootstrap test ($P < 0.05$).

Population parameters

The gross reproductive rate (*GRR*) increased from 12.68 offspring/individual at 20 °C to 19.88 offspring/individuals at 30 °C. The highest net reproductive rate (R_0) was 18.86 offspring/individual at 30 °C. The highest intrinsic rate of population increase (r) was observed at 30 °C (0.262 day^{-1}). The finite rate of increase (λ) was highest at 30 °C (1.30 day^{-1}) and lowest at 20 °C (1.09 day^{-1}). The longest mean generation time (T) at 20 °C was 27.68 days, and the shortest at 30 °C was 11.17 days (Table 2).

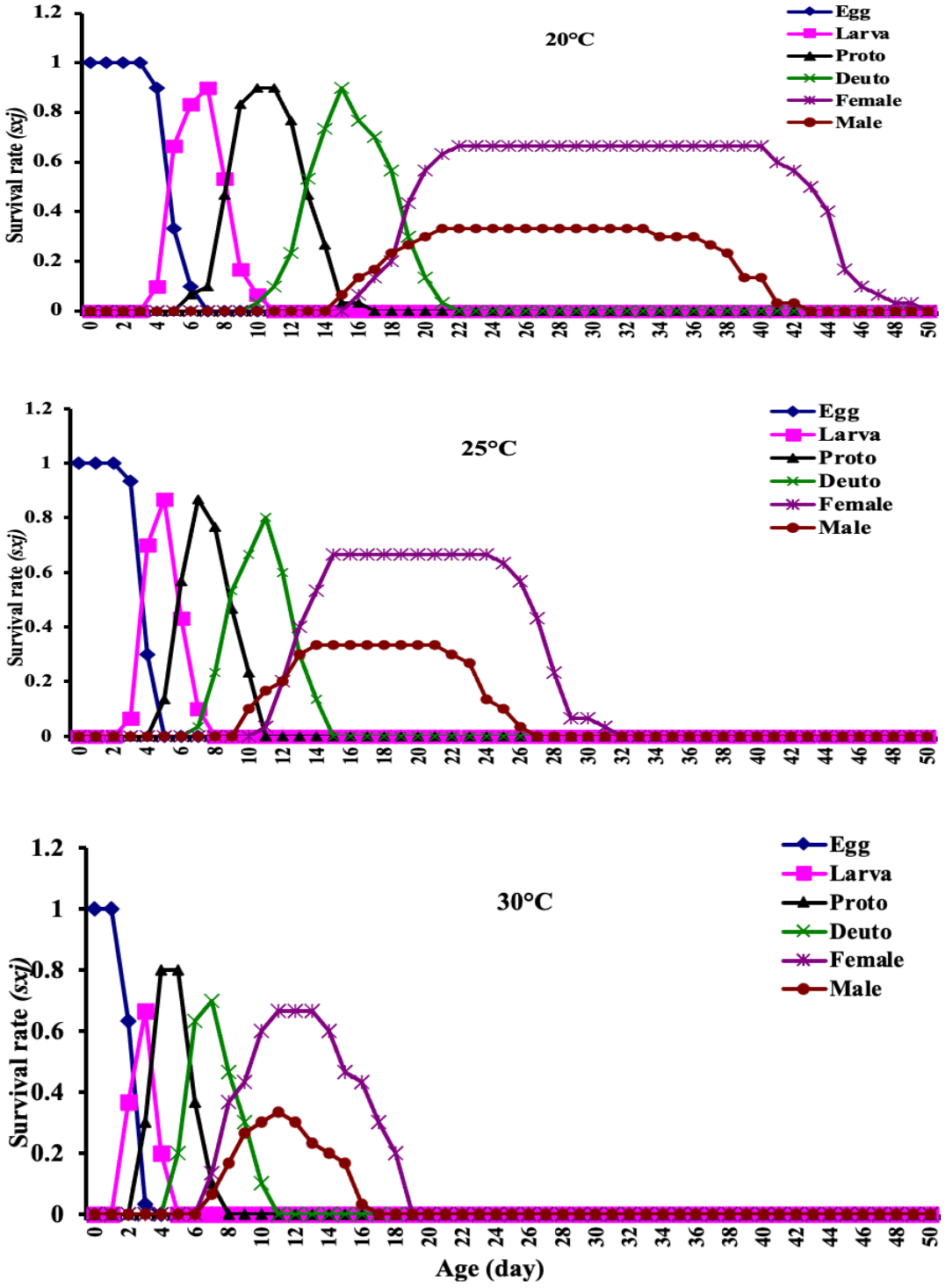

Figure 1. Age-stage specific survival rate (s_{xj}) of *Eutetranychus africanus* at different constant temperatures.

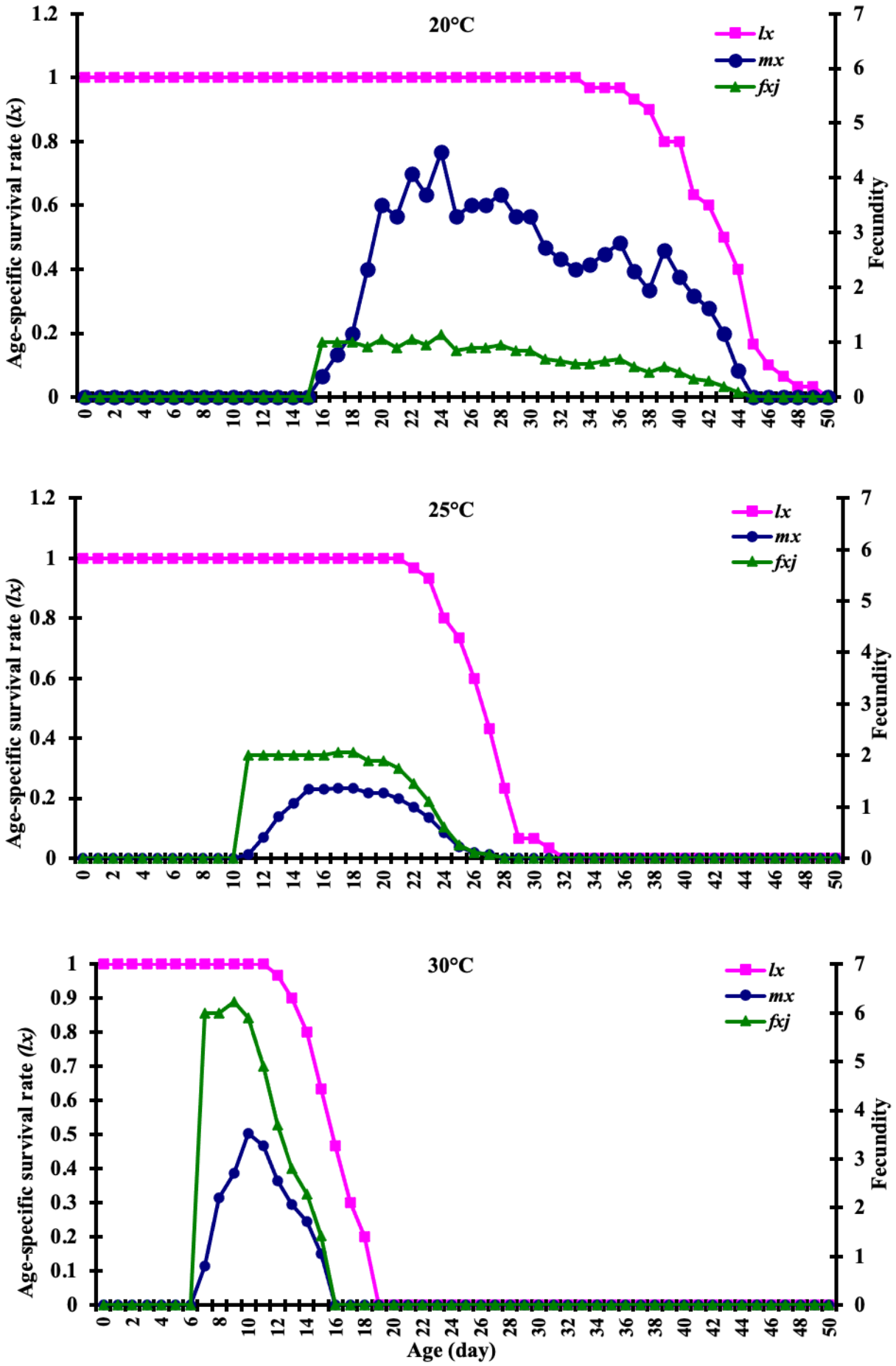

Figure 2. Age-specific survival rate (l_x), age-stage specific fecundity of female (f_{xj}), and age-specific fecundity (m_x) of *Eutetranychus africanus* at different constant temperatures.

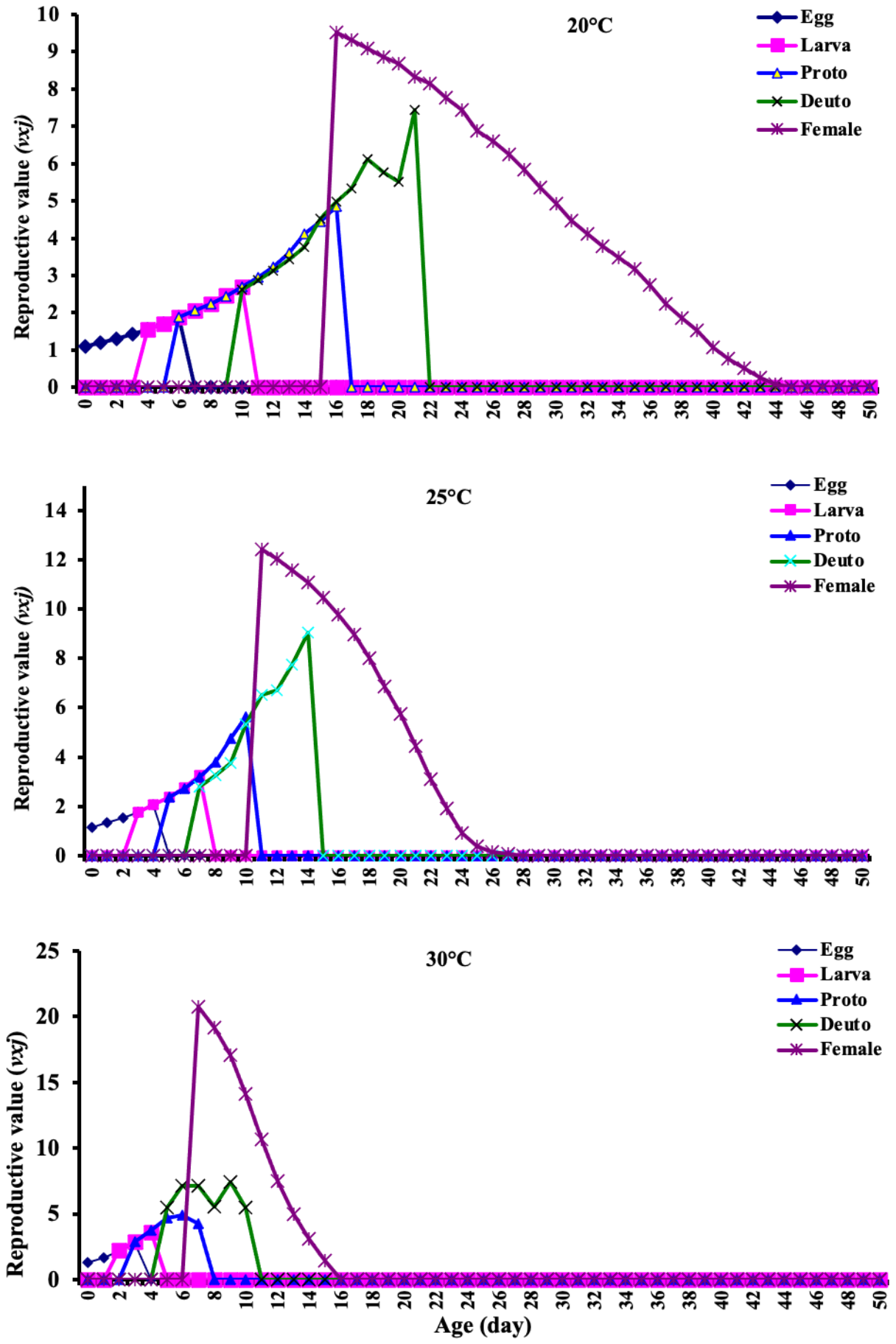

Figure 3. Age-stage specific reproductive value (v_{xj}) of *Eutetranychus africanus* at different constant temperatures.

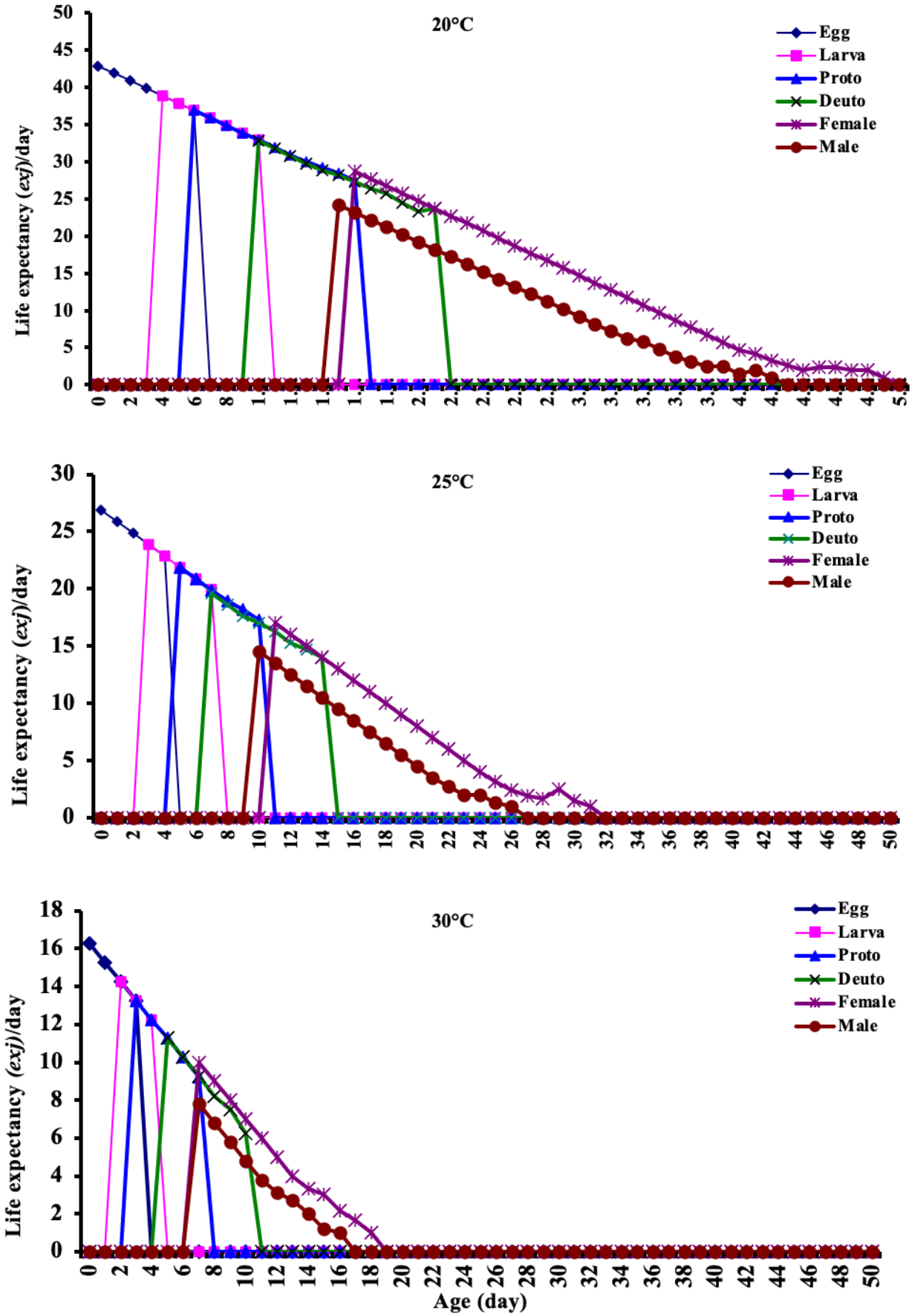

Figure 4. Age-stage life expectancy (e_{xj}) of *Eutetranychus africanus* at different constant temperatures.

DISCUSSION

The findings of this study confirm that the egg is the longest developmental stage at all temperatures, constituting approximately 50% of the total immature duration. This observation on the duration of the egg stage is consistent with previous studies on various *Eutetranychus* species, e.g., Siddig and El-Badry (1971) reported egg duration of 4.3 and 5.7 days for *E. sudanicus* El-Badry in summer and winter, while 5–6 days for *E. orientalis* by Banu and ChannaBasavanna (1972). Similarly, Afifi *et al.* (1988) documented 5.6 and 4 days for *E. palmatus* Attiah and *E. africanus*. More recent studies have also reported durations of 3.4 days at 30 °C (Abd El-Wahab *et al.* 2010) and 3.55 days (Lin *et al.* 2020) for *E. africanus*. These comparisons depict stability in duration of the egg stage between species and under different conditions, confirming the current finding.

The observed female longevity in this work aligns with previously reported findings for different *Eutetranychus* species. Several studies have documented variations in longevity across different species and environmental conditions, particularly temperature, e.g., *E. africanus* has been reported longer longevity for about 11.1 days at 30 °C (Afifi *et al.* 1988), while other studies indicate a shorter period of 7.31 days at the same temperature (Abd-El-Wahed *et al.* 2012). Similarly, *E. orientalis* exhibits variable longevity depending on temperature, with reported longevity of 7.7 days at 21.3–27.5 °C (Banu and ChannaBasavanna 1972), 15.5–16.6 at 25 °C and 12–13.8 days at 30 °C (Abd-El-Wahed *et al.* 2012).

Temperature appears to be a significant factor influencing longevity, as seen in *E. sudanicus*, with longer longevity in winter (15.2 days) compared to summer (12.8 days) (Siddig and El-Badry 1971). A similar trend is evident for *E. orientalis* where longevity decreases with increasing temperature, 19.31 days at 20 °C, 10.18 days at 25 °C, and 8.91 days at 30 °C (Metwally *et al.* 2019), similarly 13.53 days at 25 °C and 10.60 days 30 °C (Elhalawany 2019). This suggests that higher temperatures may accelerate physiological processes, leading to a shorter longevity. Additionally, the longevity of *E. africanus* at 27 °C was found to be as short as 6.89 days (Lin *et al.* 2020), further supporting the influence of temperature on survival. The findings of this study reinforce the established relationship between longevity and temperature in *Eutetranychus* species, with trends comparable to previous research. The variation in longevity across different studies may also be attributed to factors such as genetic differences, host plant quality, or experimental conditions.

The total fecundity observed in this work was lower than previously reported values for species within the same genus under similar temperature conditions. For example, Afifi *et al.* (1988) recorded a fecundity of 39.7 eggs for *E. africanus* at 30 °C, while Abd-El-Wahed *et al.* (2012) recorded a fecundity of 22.82 and 31.55 eggs at 20 and 30 °C, respectively. These values indicate a potential temperature-dependent variation in fecundity, with a general trend of higher egg production at increased temperatures. Fecundity has also been shown to vary among species within *Eutetranychus* species. Studies on *E. sudanicus* have documented higher fecundity with 32 eggs in summer and 22 eggs in winter (Siddig and El-Badry 1971), suggesting seasonal influences on reproductive output. Similarly, *E. orientalis* has a broad range of fecundity values, including 51.3 eggs at 21.3–27.5 °C (Banu and ChannaBasavanna 1972), 14.56–16.33 eggs at 20 and 30 °C, respectively (Imani and Shishehbor 2009), and 16–19 and 22–31 eggs at 25 and 30 °C, respectively (Abd-El-Wahed *et al.* 2012).

Further comparisons indicate that *E. orientalis* has recorded fecundity values of 18.2 eggs at 25 °C (Elhalawany 2019), 22.60 eggs at 30 °C (Metwally *et al.* 2019), and 15.92–29.78 eggs at 25 °C (Yalçin *et al.* 2022). Additionally, *E. africanus* at 27 °C was reported to have a fecundity of 17.61 eggs (Lin *et al.* 2020). The observed variation within and across species underscores the complexity of reproductive responses to environmental conditions. The lower fecundity in this study compared to previous reports may be influenced by multiple factors beyond temperature, such as differences in host plant suitability, experimental conditions, or genetic diversity among mite populations.

Life table parameters of *E. africanus* are very rare in the literature. However, the results of this study are similar to those reported for *E. banksi* (McGregor) by Badii *et al.* (2003). The current study indicated the highest intrinsic rate of population increases at 30 °C. This is most certainly due to the much longer

mean generation time at 25 °C. Consequently, doubling time was also considerably shorter at 30 °C than at 25 °C. The values of the net reproductive rate (R_0), the finite rate of increase (λ), and the intrinsic rate of increase (r) were higher as reported in other studies (Childers *et al.* 1991) for *E. banksi* at 20 and 25 °C, in comparison with the present study. Also, it is higher than those reported by Imani and Shishehbor (2009) for *E. orientalis* at 30 °C (0.144) on lebbek, *Albizia lebbek* (L.) Benth., in Iran. The values of net reproductive rate (R_0), the mean generation time (T), and the intrinsic rate of increase (r) were lower as mentioned by Lin *et al.* (2020) for *E. africanus* at 22, 27, and 32 °C on papaya (*Carica papaya* L.), in Taiwan, compared with the current work. In addition, Elhalawany (2019) mentioned that the highest (r) for *E. orientalis* was 0.138 individuals/female/day on castor bean (*Ricinus communis* L.) at 30 °C. The individuals had the ability to double in the shortest time at 30 °C. The mean generation time (T) and doubling time (DT) values decreased with temperature increase. This result agrees with that of Imani and Shishehbor (2009) for *E. orientalis*, where the doubling time on lebbek in Iran lasted 4.79 and 7.34 days at 30 and 20 °C, respectively.

A recent publication by Yalçin *et al.* (2022) for *E. orientalis* on citrus in Türkiye at 25 °C showed that the intrinsic rate of increase (r), the net reproductive rate (R_0), the finite rate of increase (λ), and doubling time (DT) values were 0.12 and 0.17 day−1, 10.41 and 22.36 individual/offspring, 1.13 and 1.19 day−1, and 5.59 and 4.04 days for lemon (*Citrus limon* (L.) Osbeck) and grapefruit (*Citrus paradise* Macf.), respectively. However, the shortest and longest mean generation times (T) were obtained as 18.26 days on orange (*Citrus sinensis* L.) and 19.37 days on grapefruit.

At 30 °C, daily oviposition was highest and occurred earlier than other temperatures. At that temperature, the increase and decrease in oviposition were quicker than other temperatures. Also, survivorship decreased much more quickly at 30 °C. These are the types of responses expected for arthropods and poikilothermic organisms. These findings are similar to those detected by Elhalawany (2019) for *E. orientalis*.

CONCLUSION

This study demonstrates that temperature significantly influences the development, survival, and reproduction of *E. africanus* on *P. alba*. Higher temperature accelerated development, increased fecundity, and shortened life span. The optimal population growth was observed at 30 °C, with the highest intrinsic and net reproductive rates. Developmental time decreased with increasing temperature, ranging from 18.6 days at 20 °C to 8.8 days at 30 °C for females. The oviposition period and longevity also followed this trend, with the shortest durations recorded at 30 °C. Daily oviposition rates and fecundity increased at higher temperatures, peaking at 5.4 eggs/female/day and 28.3 eggs at 30 °C. Survival rates were similar across temperatures, with males developing faster but exhibiting shorter lifespan than females. The gross reproductive rate (GRR), net reproductive rate (R_0), and finite rate of increase (λ) were all highest at 30 °C, confirming that this temperature is most favorable for population growth. Given that white frangipani is cultivated in temperatures ranging from 18–27 °C during its active growing season in spring and summer, this period is expected to be the most vulnerable to *E. africanus* infestations. The proximity of environmental temperatures to the developmental threshold of the mite suggests an increased risk of population buildup and subsequent damage. These findings aid in understanding *E. africanus* population dynamics and can inform pest management strategies. Future research should explore interactions with other ecological factors to develop effective control measures.

ACKNOWLEDGEMENTS

To Dr. G.J. de Moraes (Departamento de Entomologia e Acarologia, Escola Superior de Agricultura “Luiz de Queiroz”, Universidade de São Paulo, Brazil) for valuable comments on early versions of this manuscript and the improvement of this work. Thanks are also to Dr. M.M. Abou-Setta (Scale Insects and Mealy Bugs Department, Plant Protection Research Institute, Agricultural Research Centre, Egypt) for helping with data statistical analysis.

Author contributions: Conceptualization, methodology: experimental design, investigation, data collection, resources, writing – original draft, writing – review and editing: R.A.; software, analyses and data curation, validation, visualization, writing – review and editing: A.E. All authors have read and agreed to the published version of the manuscript.

Funding: The author(s) received no financial support for the research, authorship, and/or publication of this article.

Availability of data and materials: Data are available upon request from the authors.

Ethics approval and consent to participate: No human participants were involved in any studies conducted by the authors for this article.

Consent for publication: NA.

Competing interests: The authors declare no conflict of interest.

Generative AI statement: NA.

REFERENCES

Abd El-Wahab, H.A., Hadi, S.A. & Riad, N.F. (2010) Influence of different temperatures on the biological aspects of *Eutetranychus africanus* (Tücker) (Acari: Tetranychidae: Prostigmata). *Journal of Plant Protection and Pathology,* 1(7): 519–524. https://doi.org/10.21608/jppp.2010.86888

Abd-El-Wahed, N.M., El-Syaed, K.M. & El-Ghobashi, M.S. (2012) Biological studies on citrus brown mite *Eutetranychus orientalis* (Klein) (Tetranychidae: Acarina) when fed on leaves of *Carica papaya* varieties under laboratory conditions. *Egyptian Journal of Agricultural Research*, 90(4): 1425–1432. https://doi.org/10.21608/ejar.2012.163486

Afifi, A.M., El-Duweini, F.K., Hassan, M.F. & Megali, M.K. (1988) Biological studies on two species of *Eutetranychus* Banks with description of their immature stages (Acari: Actinedida: Tetranychidae). *Bulletin of Zoological Society of Egypt*, 36: 54–65.

Attiah, H.H. (1967) The genus *Eutetranychus* in U.A.R., with description of three new species (Acarina: Tetranychidae). *Bulletin de La Société Entomologique d'Egypt*, 51: 1–16.

Badii, M.H., Varela, S., Flores, A.E. & Landeros, J. (2003) Temperature-based life history and life table parameters of Texas citrus mite on orange (Acari: Tetranychidae). *Systematic and Applied Acarology*, 8: 25–38. https://doi.org/10.11158/saa.8.1.3

Banu, K. & ChannaBasavanna, G.P. (1972) Plant feeding mites of India-I. A preliminary account of the biology of the spider mite *Eutetranychus orientalis* (Klein) (Acarina: Tetraanychidae). *Mysore Journal of Agricultural Sciences*, 6: 253–268.

Barbosa, D.G.F., Gondim, M.G.C.Jr., Barros, R., de Oliveira, J.V. & da Silva, F.R. (2004) Compared biology of *Eutetranychus banksi* (McGregor) (Acari: Tetranychidae) on tropical fruits species. *Neotropical Entomology*, 33(4): 403–406. https://doi.org/10.1590/S1519-566X2004000400002

Birch, L.C. (1948) The intrinsic rate of natural increase of an insect population. *Journal of Animal Ecology*, 17: 15–26. https://doi.org/10.2307/1605

Bolland, H.R., Gutierrez, J. & Flechtmann, C.H.W. (1998) *World catalogue of the spider mite family (Acari: Tetranychidae)*. Leiden, Boston, Köln, Brill Press, 392 pp.

Carey, J.R. (1993) *Applied demography for biologists with special emphasis to insects*. Oxford University Press. New York, Oxford, 206 pp. https://doi.org/10.1093/oso/9780195066876.001.0001

Chi, H. (1988) Life-table analysis incorporating both sexes and variable development rate among individuals. *Environmental Entomology*, 17: 26–34. https://doi.org/ 10.1093/ee/17.1.26

Chi, H. (2018) TWOSEX-MSChart: a computer program for the age-stage, two-sex life table analysis. Available from http://140.120.197.173/Ecology/ (Accessed on 26 June 2024).

Chi, H. & Liu, H. (1985) Two new methods for the study of insect population ecology. *Bulletin of the Institute of Zoology, Academia Sinica*, 24: 225–240.

Chi, H. & Su, H.Y. (2006) Age-stage, two-sex life tables of *Aphidius gifuensis* (Ashmead) (Hymenoptera: Braconidae) and its host *Myzus persicae* (Sulzer) (Homoptera: Aphididae) with mathematical proof of the relationship between female fecundity and the net reproductive rate. *Environmental Entomology*, 35(1): 10–21. https://doi.org/10.1603/0046-225X-35.1.10

Childers, C.C., Abou-Setta, M.M. & Nawar, M.S. (1991) Biology of *Eutetranychus banksi*: Life tables on marshi grapefruit leaves at different temperatures (Acari: Tetranychidae). *International Journal of Acarology*, 17: 29–35.

https://doi.org/10.1080/01647959108683883

Dhooria M.S. (1982) Studies on ovipositional preference, host-range and seasonal incidence of *Eutetranychus orientalis* (Acari: Tetranychidae) in Delhi. *Indian Journal of Acarology*, 6: 77–83.

Elhalawany, A.S. (2019) Influence of some host plants and temperature on biological aspects of the citrus brown mite, *Eutetranychus orientalis* (Klein) (Acari: Actinedida: Tetranychidae). *Annals of Agriculture of Science Moshtohor*, 57(3): 745–754. https://doi.org/10.21608/ASSJM.2019.98137

Fisher, R.A. (1930) *The genetical theory of natural selection*. The Clarendon Press, Oxford, UK, 272 pp.

Hafez, S.M., El-Zemaity, M.S., El-Aid, N.M. & Kalif, S.K. (1984) Effect of female crowding on certain biological aspects of the citrus brown mite, *Eutetranychus orientalis* (Klein). *Annals of Agricultural Sciences, Ain Shams University*, 29: 1109–1117.

Hassan, M.F., El-Bahrawy, A.F., El-Kady, G.A., Abo-Shnaf, R. & Kamel, M.S. (2013) Phytophagous mites and their natural enemies associated with common vegetables at Ismailia governorate. *Acarines*, 7(1): 71–74. https://doi.org/10.21608/ajesa.2013.4930

Huang, Y.B. & Chi, H. (2011) The age-stage, two-sex life table with an offspring sex ratio dependent on female age. *Journal of Agriculture and Forestry*, 60(4): 337–345.

Huang, Y.B. & Chi, H. (2013) Life tables of *Bactrocera cucurbitae* (Diptera: Tephritidae): with an invalidation of the jackknife technique. *Journal of Applied Entomology*, 137(5): 327–339. https://doi.org/10.1111/jen.12002

Imani, Z. & Shishehbor, P. (2009) Effect of temperature on life history and life tables of *Eutetranychus orientalis* (Klein) (Acari: Tetranychidae). *Systematic and Applied Acarology*, 14(1): 11–18. https://doi.org/10.11158/saa.14.1.2

Jeppson, L.R., Keifer, H.H. & Baker, E.W. (1975) *Mites injurious to economic plants*. University of California Press, Barkely, USA., 614 pp. https://doi.org/10.2307/jj.8501041

Krantz, G.W. (1975) *A manual of Acarology*. Oregon State University Book Stores: Corvallis, USA, 509 pp.

Lin, M.-Y., Lin, C.-H., Lin, Y.-P. & Tseng, C.-T. (2020) Temperature-dependent life history of *Eutetranychus africanus* (Acari: Tetranychidae) on papaya. *Systematic and Applied Acarology*, 25(3): 479–490. https://doi.org/10.11158/saa.25.3.8

Metwally, A.M., Abdallah, A.A. & Abd El-Hady, M.A. (2019) Effect of temperature degrees on the duration of the phytophagous mite, *Eutetranychus orientalis* complex (Klein) (Acari: Tetranychidae) when fed on green bean (*Phaseolus vulgaris* L.). *Al-Azhar Journal of Agricultural Research*, 44(2): 172–179. https://doi.org/10.21608/ajar.2019.102950

Migeon, A. (2015) The Jean Gutierrez spider mite collection. *Zookeys*, 489: 15–24. https://doi.org/ 10.3897/zookeys.489.9292

Migeon, A. & Dorkeld, F. (2024) Spider mites web: A comprehensive database for the Tetranychidae. Available from https://www1.montpellier.inrae.fr/CBGP/spmweb (Accessed on 03 July 2024).

Ohno, S., Miyagi, A., Gotoh, T., Ganaha-Kikumura, T., Shiromoto, K., Kijima, K. & Ooishi, T. (2011) Wild host plants of four spider mite species (Acari: Tetranychidae) infesting fruit crops in Okinawa. *Journal of Asia-Pacific Entomology*, 14: 281–284. https://doi.org/ 10.1016/j.aspen.2011.03.007

Quimio, G.M., Justo, V.P., Banuag, F.N. & Astridge, D.P. (2013) Seasonal dynamics of mites infesting papaya in Northern Mindanao. *In*: Oakeshott, J. & Hall, D. (Eds.), *Smallholder HOPES—horticulture, people and soil*, Proceedings of the ACIAR–PCAARRD Southern Philippines Fruits and Vegetables Program meeting. ACIAR Proceedings 139. Australian Centre for International Agricultural Research, Canberra, pp. 79–88.

Radha, R., Sivakumar, T. & Arokiyaraj, S. (2008) Pharmacognostical evaluation of *Plumeria alba* Linn. *Research Journal of Pharmacy and Technology*, 1: 496–501. https://doi.org/10.5958/0974-360X

Rasmy, A.H. (1978) Biology of the citrus brown mite, *Eutetranychus orientalis* as affected by some citrus species. *Acarologia*, 19: 222–224.

Salman A.G.A. (1983) Effect of host plant species and temperature on population increase of the citrus-brown mite, *Eutetranychus orientalis* (Klein). *Bulletin of the Entomological Society of Egypt*, 62: 147–154.

SAS Institute (2003) SAS Statistics and graphics guide, release 9.1.3. SAS Institute, Cary, North Carolina 27513, USA.

Siddig, M.A., & El-Badry, E.A. (1971) Biology of the spider mite *Eutetranychus sudanicus*. *Annals Entomology Society of America*, 64: 806–809. https://doi.org/ 10.1093/aesa/64.4.806

Southwood, T.R.E. & Henderson, P.A. (2000) *Ecological methods*. Blackwell Science. USA, 575 pp.

Tuan, S.-J., Lee, C.-C. & Chi, H. (2014a) Population and damage projection of *Spodoptera littura* (F.) on peanuts (*Arachis hypogaea* L.) under different conditions using the age-stage, two-sex life table. *Pest Management Science*, 70: 805–813. https://doi.org/ 10.1002/ps.3618

Tuan, S.-J., Lee C.-C. & Chi, H. (2014b) Erratum: Population and damage projection of *Spodoptera littura* (F.) on peanuts (*Arachis hypogaea* L.) under different conditions using the age-stage, two-sex life table. *Pest Management Science*, 70: 1936. https://doi.org/10.1002/ps.3920

Yalçin, K., Döker, İ. & Kazak, C. (2022) Impact of citrus species on the biological characteristics and life table parameters of *Eutetranychus orientalis* (Klein) (Acari: Tetranychidae). *Systematic and Applied Acarology*, 27(1): 107–117. https://doi.org/10.11158/saa.27.1.11

Zaher, M.A. (1984) *Survey and ecological studies on phytophagous, predaceous and soil mites in Egypt. 1. Phytophagous mites in Egypt (Nile Valley and Delta)*. PL. 480 programme, USA., Project No. EG-ARS-30, Grant No. FG-EG-139, 228 pp.

اثر دما بر پراسنجه‌های زیستی هرنای *Eutetranychus africanus* (Tücker) (Acari: Tetranychidae) روی گل یاس سفید

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دریافت
۲۴ خرداد ۱۴۰۴

پذیرش
۱۴ مهر ۱۴۰۴

انتشار
۲۵ دی ۱۴۰۴

دبیر تخصصی
آ. فرازمند

چکیده

این مطالعه به بررسی اثر دما بر رشد، زنده‌مانی و تولیدمثل کنهٔ *Eutetranychus africanus* (Tücker) (Acari: Tetranychidae) پرورش یافته روی گل یاس سفید (*Plumeria alba* L.: Apocynaceae) در شرایط آزمایشگاهی می‌پردازد. رشد، زنده‌مانی و تولیدمثل این کنه روی واحدهایی ساخته شده از برگ‌های جدا شدهٔ *P. alba*، در سه دمای ثابت (۲۰، ۲۵ و ۳۰ ± ۲ درجهٔ سلسیوس)، رطوبت نسبی (۷۰ ± ۵ درصد) و دورهٔ نوری ۱۶: ۸ (روشنایی: تاریکی) مورد مطالعه قرار گرفت. کنه‌ها چرخهٔ زندگی خود را تکمیل و در هر سه دمای آزمایش شده تولیدمثل کردند. با افزایش دما، زمان نمو، دورهٔ تخم‌گذاری، طول عمر و دورهٔ زندگی هرنای کامل کاهش یافت، اگرچه میزان تخم‌گذاری روزانه و باروری افزایش یافت. نتایج نشان داد که در حالی که *E. africanus* در طیف گسترده‌ای از دماها رشد می‌کند، دمای ۳۰ درجهٔ سلسیوس بیشترین میزان ذاتی افزایش (r) ، میزان خالص تولیدمثل (R_0) و کوتاه‌ترین زمان برای دو برابر شدن جمعیت (DT) دارای است. میزان ناخالص تولیدمثل (GRR) نیز در دمای ۳۰ درجهٔ سلیسوس به بیشترین مقدار خود رسید. این مطالعه می‌تواند گامی مهم برای تامین مالی استقرار آیندهٔ مهار موثر کنه‌ها باشد.

واژگان کلیدی: هرنای قرمز آفریقایی، رشد، مصر، دورهٔ زندگی، گل یاس سفید، زنده‌مانی

CITE: Abo-Shnaf, R., & Elhalawany, A.S. (2026) Effect of temperature on biological parameters of *Eutetranychus africanus* (Tücker) (Acari: Tetranychidae) on white frangipani. *Persian Journal of Acarology*, 15(1): 150101.
https://doi.org/10.22073/pja.v15i1.85761