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Research Article

Keywords: longevity, doubling time, avocado brown mite, life expectancy, entropy

Posted Date: September 18th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10944145/v1

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Additional Declarations: No competing interests reported.

Survival and mortality of females and males of *Oligonychus punicae* (Trombidiformes: Tetranychidae) on three host plants under laboratory conditions

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Abstract. Variation in survival and mortality of adult female and male mites has been insufficiently studied. Quantifying the rate of biological aging is crucial for understanding the population's overall ecological strategy and for developing new, environmentally friendly control methods. Survival curves illustrate the sensitivity of arthropods to various environmental conditions, sex, genotype, food resources, and social interactions. We evaluated the survival and mortality of females and males of *Oligonychus punicae* Hirst (Trombidiformes: Tetranychidae) on squares of avocado (*Persea americana* Mill.; Lauraceae), rose (*Rosa hybrida* L.; Rosaceae), and guamuchil (*Pithecellobium dulce* [Roxb.] Benth.; Fabaceae) leaves under laboratory conditions. The log rank test showed significant differences in survival distribution between females and males ($P < 0.05$). Females lived shorter lives than males on avocado (35 versus 44 days), guamuchil (31 versus 37 days), and rose (31 versus 37 days). In both sex, longevity was greatest on avocado leaf squares compared to guamuchil and rose squares. Both sexes exhibited a type I survival curve on the tested plants. The Gompertz model showed that the logarithm of the instantaneous mortality rate increases linearly with age of *O. punicae* on the three host plants. The mortality rate doubling time (*DT*) for both female and male *O. punicae* was shorter on guamuchil and rose leaves squares than on avocado leaves, indicating a faster increase in mortality when feeding on guamuchil and rose leaves squares compared to avocado leaves. Survival and mortality rates suggest that *P. dulce* and *R. hybrida* are unsuitable hosts for *O. punicae* adults, and that the greatest longevity and slowest decline in mortality of *O. punicae* adults were observed in *P. americana* cultivar Hass. These findings highlight that socio-sexual interactions in *O. punicae* represent a clear instance of sexual conflict, where male harassment or mating drastically reduces female fitness by compromising survival.

Keywords: longevity; doubling time; avocado brown mite; life expectancy; entropy

Introduction

Mexico is the world's leading producer of avocados (*Persea americana* Mill.; Lauraceae), with an annual output of 2,761,327 tons valued at nearly 57 million Mexican pesos (DGSIAP 2025a). Rose cultivation (*Rosa hybrida* L.; Rosaceae) also contributes significantly to the economy, generating 2,627,802 Mexican pesos from 10,158,778 harvested rose bushes (DGSIAP 2025a). The United States is the primary importer of both Mexican avocados and roses (DGSIAP 2025b). The guamuchil tree (*Pithecellobium dulce* [Roxb.] Benth.; Fabaceae) is cultivated for food, fodder, adhesives, fragrances, dyes, fuel, and medicines in Colombia, Cuba, the United States, Jamaica, Mexico, Puerto Rico, and Venezuela (Vargas-Madriz et al. 2020). These three plants are notable hosts for various arthropod pests, including *Oligonychus* spp. (Trombidiformes: Tetranychidae) (Migeon and Dorkeld 2025).

Oligonychus punicae (Hirst) (Trombidiformes: Tetranychidae) feeds on 97 plant species from 34 families (Migeon and Dorkeld 2025) and is a major pest of avocado crops (Peña and Wysoki 2008). These mites feed by inserting their stylets between epidermal cells or through stomata, consuming mesophyll cell contents and causing cell death and leaf defoliation (Bensoussan et al. 2016). Chemical pesticides are commonly used to control *O. punicae* due to their significant impact on crops (Peña and Wysoki 2008). However, excessive pesticide use, combined with the mite's short generation time and rapid growth rate (Cerna et al. 2009; Ferraz et al. 2020; González-Hernández et al. 2024), increases the risk of resistance development (Li 1995). These challenges underscore the need for more ecological information to improve management strategies. In particular, analyzing survival

and mortality patterns across different host plants is essential to determine the life spans and timing of mortality for both male and female mites.

González-Hernández (2024) reported the survival of immature stages and the longevity of female *O. punicae* on rose, guamuchil, and avocado, but did not report the longevity of males, nor the mortality rate, mortality doubling time, or the type of survival curve for adult female and male *O. punicae*. This may be because not all pairs of females and males used by González-Hernández (2024) were the same age, as the role of the males used in that study was to mate with the females. Furthermore, they did not report whether the host plants modify the type of survival curve for females.

Previous studies have analyzed the survival curve (l_x) of adult female *O. punicae* on avocado (Cerna et al. 2009). This prior research focused on female *O. punicae* survival on three avocado varieties (Hass, Fuerte, and Criollo). However, there is a lack of information on the survival curve and mortality rate of male *O. punicae* on avocado, rose, and guamuchil. Thus, a gap remains regarding sex-specific survival data across different host plants. As survival curves reflect mortality influenced by environmental conditions, sex, genotype, and food resources (Rabinovich 1978), addressing this gap is critical. Understanding senescence, as the age-related increase in mortality, is a key goal in evolutionary ecology and requires comparative, cross-organism studies (Rabinovich et al. 2010). The aim of this research was to evaluate the mortality and survival of both female and male *O. punicae* on avocado, rose, and guamuchil under laboratory conditions.

Materials and methods

This research was conducted at the Facultad de Ingeniería y Ciencias de la Universidad Autónoma de Tamaulipas (FIC-UAT), Tamaulipas, Mexico. Immature and adult

O. punicae were collected from the guamuchil tree located in the urban area (23.7440000 °N, 99.1659997 °W, 329 m a.s.l.) of Ciudad Victoria, Tamaulipas, Mexico. To increase the *O. punicae* population, the mites were placed on bean plants (*Phaseolus vulgaris* L. var Michigan; Fabaceae). The bean plants were grown in plastic pots (12 cm diameter, 10 cm height) under field conditions for 3 months (three generations) before the experiments were conducted.

Plant material. The following plants were used: avocado (*P. americana* cultivar Hass), guamuchil (*P. dulce*), and rose (*R. hybrida*). At the time of the experiment, the avocado plant was 3 years old, the guamuchil 15 years old, and the rose 2 years old, and all were under field conditions. The three host plants were fertilized once a week with HUMIMAX (humic substances derived from leonardite at 12%, soluble potassium at 2%, amino acids at 0.5%, manganese (Mn) at 3%, iron (Fe) at 3%, zinc (Zn) at 1%, boron (B) at 0.5%, and wetting agents, dispersants, and penetrants at 78%) (Agrofersa, Saltillo, Coahuila, Mexico), at a rate of 6 ml per liter of water. For 30 days, the plants were not treated with pesticides to avoid residual effects on the mites. For the study, mature leaves were collected from the middle section of the host plants. At the time of leaf cutting, the *P. americana* tree was approximately 2 m tall, *P. dulce* 3 m, and *R. hybrida* 1.3 m. A multi-functional brush cutter was used to cut the leaves of the avocado and guamuchil trees. This activity was carried out with great care to minimize damage to the trees. The leaves showed no symptoms of fungal or bacterial diseases, nor of mechanical or insect damage. The leaves were transported in resealable plastic bags placed in a cooler with frozen gel packs at a temperature of 4–8 °C to the plant physiology laboratory at FIC-UAT. The approximate transport time for the leaves to the laboratory was 15–20 minutes. To eliminate any phytopathogens on the leaves, they

were immersed in a 1.5% sodium hypochlorite solution for 2 minutes, then rinsed with running water. They were immediately dried with absorbent paper and left to stand for 30 minutes. The leaves were then cut into 4 cm^2 squares using a scalpel.

Experimental arena. Thirty female and thirty male *O. punicae* mites in the teliochrysalis stage (quiescent deutonymph) were randomly selected. In this stage, the female is globose, larger, and red, but darker than the protonymph. The male, on the other hand, is longer and has a more pointed hysterosoma than in its protonymph stage. A pair of mites (male and female) was placed on each leaf square of each host plant using a fine camel-hair brush, resulting in 30 pairs per host plant. Moistened cotton was placed in a 5 cm-diameter Petri dish, and a leaf square was placed on top, with the upper surface facing upwards. Because the leaf squares age and lose nutritional quality over time, new leaves were collected every 3 days, and the same cleaning procedure was performed, with the females and males being transferred to these new leaf squares. During the experiment, three females and two males died because they became entangled in the cotton threads and drowned, leaving their mates alone. Therefore, the data analysis was performed using 25 pairs.

We monitored 25 pairs of adult female and male *O. punicae*. Each day, we recorded the number of survivors (l_x), survival period (p_x), mortality frequency (d_x), and additional life expectancy (e_x) for both sexes on three host plant species. The variable x indicates the mite age (Carey 1993, Carey 2001).

Data analysis. All analyses were performed using R software version 4.5.1 (R Core Team 2025). We used the Weibull distribution to compare adult female and male *O. punicae* survival on avocado, rose, and guamuchil leaves in the laboratory. The probability that a female survives to time t is given by (Bouras and Papadoulis 2005).

$$S(t) = e^{-\left(\frac{t}{b}\right)^{c}} para\ t \geq 0 \qquad (1)$$

where *c* and *b* are the scale and shape parameters, respectively. The shape parameter (*c*) was used to distinguish between the types of survival curves. If c > 1, it describes a type I survival curve, indicating that the mortality rate increases with age. If *c* = 1, it describes a type II survival curve and reveals a constant mortality rate. If *c* < 1, it defines a type III survival curve, showing a decreasing mortality rate with age (Pinder et al. 1978; Bouras and Papadoulis 2005). The scale parameter (*b*) indicates the host plant (avocado, rose, or guamuchil) on which the *O. punicae* population declines, at the slowest rate, as reflected by higher *b* values. However, statistically equivalent *c* values between two populations do not necessarily indicate similar mean longevities. Populations may share comparable shape parameters but still differ in mean longevity (Pinder et al. 1978). The mean longevity of females and males was estimated using both the *c* and *b* parameters {mean = b × Γ[1 + (1/c)]} using the "gmma" function (Pinder et al. 1978). The "R2nls" function estimated the pseudo-coefficient of determination (Pseudo-R^2) as a measure of the fit of the Weibull model to the survival data (Schabenberger and Pierce 2002). The parameters *c* and *b*, and their 95% confidence intervals (95% CI), were estimated using the "nls" and "confint2" functions. If the 95% CIs of the estimated scale parameter for each *O. punicae* population overlap, there are no significant differences at the 5% level (Julious 2004). The log-rank test was used to examine the null hypothesis of no differences in the survival curves of *O. punicae* among the three host plants (Méndez-Ramírez et al. 1984; Vera-Graciano et al. 1997).

The instantaneous mortality rate (μ_x) was estimated according to the equations (Carey 2001):

$$\mu_x = -\ln(p_x) \qquad 2$$

o

$$\mu_x = -\frac{1}{2}[\ln(p_{x-1}) + \ln(p_x)] \qquad 3$$

where p_x is the age-specific (period) survival $p_x = l_{x+1}/l_x$ and $l_x = N_x/N_0$). The μ_x data from equations 2 or 3 were used to estimate the parameters *a* and *b* of the Gompertz mortality model. This model assumes that μ_x is an exponentially increasing function with age (*x*). We used the linearized version of the model ($\mu_x = ae^{bx}$).

$$\ln(\mu_x) = \ln(a) + bx \qquad 4$$

where *a* is the initial mortality rate and *b* describes the senescence rate, as its magnitude determines how quickly the mortality rate will increase with the addition of days. Non-zero, continuous μ_x data were used for the linearized model (Chaves et al. 2004). Equations 2 or 3 were used to estimate *a* and *b* for the linearized model, but the one with the lowest Akaike information criterion (AIC = 2p−2ln(L)) was selected, where *p* is the number of predictor variables in the model, and *L* is the value of the likelihood function for the model. To estimate the AIC value, we use the "AIC" function. The Gompertz model provides the mortality doubling time, defined as the time required for mortality to double:

$$DT = \ln(2)/b \qquad 5$$

The parameters *a* and *b*, the doubling time, and their 95% confidence intervals (95% CI), were estimated using the "lm" and "confit" functions. If the 95% CIs for the estimated mortality rate and doubling time for each *O. punicae* population overlap, there are no significant differences at the 5% level (Julious 2004). In addition, the heterogeneity of the mortality distribution of female and male *O. punicae* was measured (Carey 1993, 2001).

$$H = \frac{\sum_{x=0}^{\omega} d_x e_x}{e_0} \qquad 6$$

H can be interpreted as the proportional increase in life expectancy at birth if all deaths were prevented as early as possible. To further clarify, if $H = 0$, all adult mite individuals die at the same age, and l_x is rectangular. In contrast, if $H = 1$, it indicates that all adult mites have the same probability of dying at each age, and l_x decreases exponentially. For values where $H < 1$ or $H > 1$, this indicates that l_x is convex or concave, respectively (Vaupel 1986, Carey 2001).

Results

Table 1 presents the estimated *c* and *b* parameters of the Weibull model for female *O. punicae* survival on avocado (*P. americana*), guamuchil (*P. dulce*), and rose (*R. hybrida*) leaf squares, along with the model's goodness of fit. The Weibull model fit the data well, with pseudo-R^2 values of 0.9819, 0.9987, and 0.9986. For all three host plants, the shape parameter (c) exceeded 1, indicating a type I survival curve where mortality risk increases with age. The scale parameter (*b*) was significantly higher for avocado (*b* = 26.1987) than for guamuchil (b = 22.3644) and rose (b = 22.3965), suggesting a slower decline in the O. punicae population on avocado. No significant difference was observed between guamuchil and rose, indicating similar population declines on these hosts (Table 1).

For males, the Weibull model fit the data for these host plants, with pseudo-R^2 values of 0.9711, 0.9917, and 0.9926, respectively. The shape parameter *c* was greater than one (*c* > 1), indicating a type I survival curve for all three plants and an increased risk of male death with age. The scale parameter (*b*) was significantly higher for males on avocado (*b* =

31.6877) than on guamuchil (b = 27.0141) or rose (b = 26.8504), showing that the male population declines more slowly on avocado than on rose or guamuchil (Table 1).

Table 1. Weibull function parameters values for the survival curves of *Oligonychus punicae* females and males on *Persea americana*, *Pithecellobium dulce,* and *Rosa hybrida*.

Host Plant	Sex	Parameters		LT_{50-P}	LT_{50-E}	Seudo-R^2
		c	*b*			
Persea americana	Female	3.5587 (3.2833–3.8341)	26.1987 a (25.7727–26.6245)	24–25	21–22	0.9819
	Male	3.0212 (2.6768–3.3656)	31.6877 z (30.8259–32.5493)	29	25–26	0.9711
Pithecellobium dulce	Female	3.9263 (3.7822–4.0704)	22.3644 b (22.2066–22.5223)	21–22	20–21	0.9987
	Male	4.2704 (3.9091–4.6315)	27.0141 y (26.6070–27.4211)	24–25	23–24	0.9917
Rosa hybrida	Female	3.9749 (3.8357, 4.1140)	22.3965 b (22.2474–22.5456)	21–22	22–21	0.9986
	Male	4.1419 (3.8039–4.4798)	26.8504 y (26.4491–27.2516)	24–25	24–25	0.9926

b: shape parameter values followed by the same letter are not significantly different (test based on the 95% CI of overlap, Julious 2004). $LT_{50–P}$: Time predicted by the Weibull model at which the female population of *O. punicae* is reduced to 50%. $LT_{50–E}$: Time observed from experimental data at which the female population of *O. punicae* is reduced to 50%.

Females survived for 35 days on avocado and 31 days on both guamuchil and rose. Adult female survival began to decline on day 14 on avocado and on day 11 on guamuchil and rose bushes. The decline accelerated after day 16 for guamuchil and rose, but not until after day 19 for avocado, indicating a slower mortality rate on avocado (Figure 1). This pattern aligns with the log-rank test, which showed significant differences in survival

distributions among host plants (χ^2 = 6.6673, *df* = 2, *P* = 0.0357). Pairwise comparisons revealed no significant difference between rose and guamuchil (χ^2 = 0.0835, df = 1, *P* = 0.7726), but significant differences between rose and avocado (χ^2 = 4.4559, *df* = 1, *P* = 0.0347) and between guamuchil and avocado (χ^2 = 4.5135, *df* = 1, *P* = 0.0336). Across all three host plants, the proportion of live *O. punicae* females declined over time. The observed time to 50% population reduction closely matched both Weibull distribution predictions ($LT_{50–P}$) and experimental data ($LT_{50–E}$) (Table 1, Figure 1).

The survival distribution of *O. punicae* males differed significantly among avocado, guamuchil, and rose bushes (log-rank test, χ^2 = 6.1551, *df* = 2, *P* = 0.0460). Pairwise comparisons showed no significant difference between rose bushes and guamuchil (χ^2 = 0.0833, *df* = 1, *P* = 0.7727). However, we found a significant difference between rose bushes and avocado (χ^2 = 4.1799, *df* = 1, *P* = 0.0409) and between guamuchil and avocado (χ^2 = 3.9854, *df* = 1, *P* = 0.0458). Male survival was highest on avocado leaf squares (44 days), compared to guamuchil and rose bushes (37 days). On avocado, male survival began to decline on day 17, while on rose and guamuchil, the decline began on day 16. The rate of decline increased after days 20, 21, and 22 for rose bushes, guamuchil, and avocado, respectively (Figure 1). Across all host plants, the proportion of live *O. punicae* males decreased with age. The time at which the male population was reduced by 50% matched both the Weibull distribution predictions ($LT_{50–P}$) and the experimental data ($LT_{50–E}$) (Table 1, Figure 1).

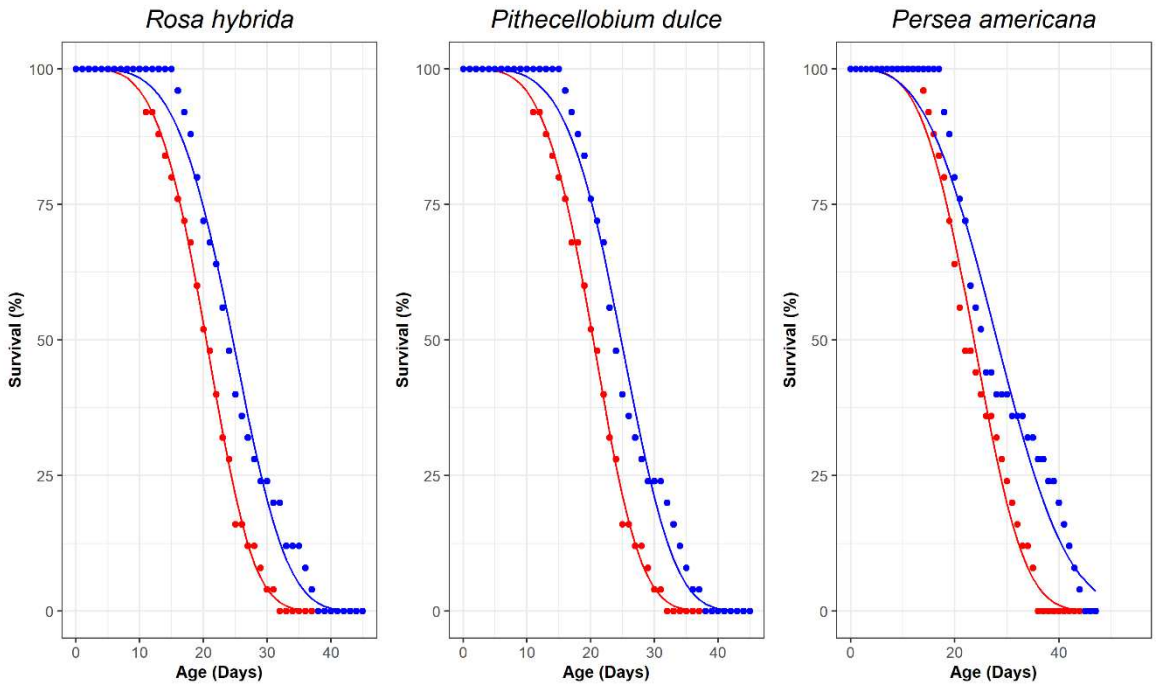


Figure 1: Survival curves of *Oligonychus punicae* adult females and males on *Persea americana*, *Rosa hybrida,* and *Pithecellobium dulce*. Observed values (dots) for males (blue) and females (red) and estimated values using the Weibull distribution model (solid line).

The survival distribution of *O. punicae* differed significantly between females and males when fed on rose bushes ($\chi^2 = 6.4830$, $df = 1$, $P = 0.0108$), guamuchil ($\chi^2 = 7.2741$, $df = 1$, $P = 0.0069$), and avocado ($\chi^2 = 5.7051$, $df = 1$, $P = 0.0169$). Males consistently lived longer than females (Figure 1). Female longevity was 20.25 days on *P. dulce*, 20.29 days on *R. hybrida*, and 23.60 days on *P. americana*. Male longevity was 24.9 days on *R. hybrida*, 24.58 days on *P. dulce*, and 28.31 days on *P. americana*. These results indicate that host plant species affect longevity.

Table 2 presents the parameter estimates a and b for the linearized Gompertz mortality model in *O. punicae* females and males on avocado, guamuchil, and rose bushes. Models linearized with equations 2 and 3 were fitted to mortality data for both sexes across the three host plants, yielding significant values between 0.7808 and 0.8428. The estimated b parameter (model slope) was positive, indicating that the logarithm of mortality (μ_x) increases linearly with age. Female mortality was highest on rose bushes, though not significantly different from guamuchil and avocado. In contrast, male mortality was significantly lower on avocado than on rose bushes and guamuchil. The doubling time (*DT*) for female mortality was shortest on rose bushes, but differences among host plants were not significant. For males, *DT* was significantly longer on avocado than on the other hosts. Overall, *DT* was shorter for females than for males (Table 3).

The entropy (*H*) of *O. punicae* adult females and males on the three host plants ranged from 0.2350 to 0.2947. A 1% change in the female mortality curve led to a 25.09%, 25.19%, and 26.15% change in female lifespan for rose bushes, guamuchil, and avocado, respectively. For males, a 1% change in mortality resulted in a 24.11%, 23.50%, and 29.47% change in lifespan for the same host plants. These findings show that small changes in mortality significantly affect lifespan in both sexes. The survival timeline of *O. punicae* was convex across all three host plants ($H < 0.05$).

Table 2. Linearized Gompertz model parameters values for the mortality of *Oligonychus punicae* females and males on avocado (*Persea americana*), guamuchil (*Pithecellobium dulce*), and rose (*Rosa hybrida*).

Parameters	Females			Males		
	Avocado	**Rose**	**Guamuchil**	**Avocado**	**Rose**	**Guamuchil**
a	–4.2954	–4.7607	–4.7325	–3.9706	–4.9458	–4.9343
$CI_{95\%}$	–4.8312, –3.7597	–5.3213, –4.2002	–5.3026, –4.162	–4.6597, –3.2816	–5.6155, –4.2761	–5.6248, –4.2437
b	0.0903 a	0.1272 a	0.1259 a	0.0656 z	0.1193 y	0.1157 y
$CI_{95\%}$	0.0678, 0.1128	0.1004, 0.1541	0.0987, 0.1532	0.0431, 0.0881	0.0924, 0.1462	0.0884, 0.1430
Doubling time	7.6766	5.4478	5.5029	10.5587	5.8085	5.9889
$CI_{95\%}$	10.2222, 6.1460	6.9033, 4.4992	7.0242, 4.5233	16.0795, 7.8600	7.5000, 4.7395	7.8381, 4.8457
R^2 value	0.8085	0.8384	0.8309	0.6895	0.8466	0.8246
degrees of freedom	1, 17	1, 19	1, 19	1, 17	1, 16	1, 17
F value	71.7769	98.5433	93.4005	37.7604	88.3448	79.9745
P value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Equation	Eq. (2)	Eq. (2)	Eq. (2)	Eq. (2)	Eq. (3)	Eq. (3)
H	0.2615	0.2509	0.2519	0.2947	0.2411	0.2350

Discussion

The survival time (l_x) of *O. punicae* on avocado, guamuchil, and rose decreased with age in both females and males. This decrease varied among host plants, indicating that host plant species affected *O. punicae* survival. These discrepancies may be associated with the fact that rose leaves (Flores-Canales et al. 2011) and guamuchil leaves (Del Ángel-Castro et al. 2019) contain secondary metabolites that can affect arthropod survival, which could contribute to the difference in survival time between males and females on rose bushes and

guamuchil compared to avocado, the latter being the main host plant of *O. punicae* (Estrada-Venegas et al. 2002).

Ferraz et al. (2021) reported that l_x of female *O. punicae* depends on the *Eucalyptus* species (*E. urophylla* S.T. Blake, *E. brassiana* S.T. Blake, *E. grandis* M. Hill ex Maiden, *E. tereticorinis* Sm., *E. pellita* F. Muell., and *Corymbia citriodora* (Hook.) K.D. Hill & L.A.S. [Myrtaceae]). Cerna et al. (2009) reported that the l_x of female *O. punicae* does not depend on the avocado variety (Fuerte: 30 d; Hass and Criollo: 31 d). Other *Oligonychus* species show differences in l_x when feeding on different host plants and at different leaf ages. *Oligonychus litchii* Lo & Ho (Trombidiformes: Tetranychidae) showed different l_x on four commercial lychee cultivars (*Litchi chinensis* Sonn; Sapindaceae) (Yao et al. 2019). Chaaban et al. (2011) reported that the survival of female *Oligonychus afrasiaticus* (McGregor) (Acari: Tetranychidae) depends on the date palm variety (*Phoenix dactylifera* L.; Arecaceae). Rioja et al. (2019) found that the survival rate of female *Oligonychus yothersi* McGregor (Acari: Tetranychidae) depends on the age of Hass avocado leaves, with higher survival on mature leaves.

The 95% confidence intervals for the Weibull model's shape parameter (*b*) overlapped for *O. punicae* populations on rose bushes and guamuchil (Tables 1 and 2), but not on avocado, indicating a difference in lifespan among populations. Pinder et al. (1978) note that populations with similar shape parameters may still have different mean longevities. Although parameters *a* and *b* were similar for mites feeding on guamuchil and rose, this does not ensure similar mean longevity, as both parameters influence it (Pinder et al. 1978). The survival curve confirmed this, showing a slower decline in *O. punicae* populations on avocado. While females and males on all three host plants exhibited a Type I survival curve,

their longevities varied, resulting in different life tables (Pinder et al. 1978). These findings are consistent with González-Hernández et al. (2024), who also reported significant differences in life tables and longevities of *O. punicae* on the same host species under similar environmental conditions.

Mortality doubled faster for both females and males on guamuchil and rose bushes than on avocado. Female mortality doubled faster than male mortality (Table 3). Entropy analysis indicated that small increases in mortality have a greater impact on female lifespan, and female survival declines more rapidly, as females expend energy on egg laying. Rabinovich et al. (2010) found a link between egg-laying effort and age-specific mortality rates, suggesting density dependence. Since reproductive costs differ by sex, females allocate more energy and nutrients to mating and egg production.

Males, by contrast, invest in sperm and seminal fluid production and spend time and energy on courtship (Li and Zhang 2021b). As a result, females have different nutritional requirements for reproduction and survival than males (Wu et al. 2020). Li and Zhang (2018, 2019, 2021a) showed that dietary needs differ between sexes because of reproductive and behavioral differences. Females require more protein and lipids during egg production, while males need more carbohydrates to support mate searching and mating. These differences primarily affect survival and fecundity, and mortality rates vary due to intrinsic mortality differences (Rabinovich et al. 2010).

Male and female *O. punicae* exhibited different lx values on the same host plant, with males consistently living longer across all three host species. Li and Zhang (2018) found that mating reduces female lifespan, aligning with our findings. Wu et al. (2020) noted that females have distinct nutritional needs for reproduction and survival, and that spider mite social behavior influences survival rates. Li and Zhang (2018) also observed that adult female

Tetranychus urticae Koch (Acari: Tetranychidae) lived shorter lives than males on bean discs (*P. vulgaris*). According to Li and Zhang (2021a), female *T. urticae* have lower lx when interacting with males. Interactions between sexes are energy- and time-intensive for females, decreasing their life expectancy due to increased investment in egg production and resulting in lower lifetime fecundity compared to virgin females (Li and Zhang 2021b). Sexual harassment by males may further reduce female lifespan, as females spend additional time and energy avoiding harmful male behaviors, which can lower their feeding rate (Li and Zhang 2021b).

In conclusion, this study demonstrates that intersexual interaction has a greater negative impact on female survival and mortality than on males. Overall, the findings confirm that host and sex are relevant factors in explaining the survival dynamics of *O. punicae* and should be considered in studies aimed at understanding its establishment and population growth. This information provides a basis for selecting experimental hosts and more accurately interpreting the demographic response of *O. punicae* in studies of its biology, ecology, and management. While this effect was observed in laboratory settings, field interactions may be more complex because population densities and resource availability vary. Further research should examine the effects of intersexual interaction in *O. punicae*, including comparisons between virgin and mated mites. It is also important to determine whether male *O. punicae* assist female dispersal to other plants, which could reduce the costs of sexual harassment and support new colony formation. Although additional research is needed, apply chemical or biological controls before males harass females that disperse to new host plants. These findings can inform management strategies for *O. punicae*, as mating influences offspring sex (diploid females or haploid males), longevity, fecundity, and

population growth. Mated females produce both sexes, enabling rapid population expansion, while unmated females produce only males.

Author contributions All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Y.A.G.-G. and J. C.C.-H., S.O.-S., R.D.-M., M.R.-R., S.G.M.-R., I.V. L.-S., and J.L.D.-Á.. The first draft of the manuscript was written by Y.A.G.-G. and J. C.C.-H. and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Funding No funding was received for conducting this study.t.

Data availability The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Competing interests The authors declare no competing interests.

Ethics approval Not applicable.

Consent to participate Not applicable.

Consent to publish Not applicable.

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