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Article

Effect of different pollen grains on life table parameters of *Neoseiulus barkeri* (Acari: Phytoseiidae)

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Abstract.

The predatory mite, *Neoseiulus barkeri* Hughes is one of the most important phytoseiid mites to control phytophagous mites. The effect of different diets such as, corn pollen, walnut pollen, sunflower pollen, date pollen, bee pollen along with the two-spotted spider mite (*Tetranychus urticae* Koch) eggs on life table parameters of the predatory mite was determined on strawberry detached leaves in Petri dishes. The experiments were carried out under laboratory conditions at 27 ± 1°C, 16L: 8D h photo-period and 70 ± 5% RH. The individuals of the predatory mite were collected from cucumber field infested with the two-spotted spider mite of Khoramabad, Lorestan Province. The results indicated that mean preimaginal developmental time was the highest on sunflower pollen and bee pollen than the preimaginal developmental time on the other tested pollens. The developmental time of adult of *N. barkeri* when fed with bee pollen (10.0 and 9.25 days for female and male, respectively) is longer than when it fed on the other diets. The fecundity rate of predatory mite on different diets did not show any significant difference. The intrinsic rate of increase (*r*) of the predatory mites fed with sunflower pollen (0.212 d^{-1}), date pollen (0.225 d^{-1}) and corn pollen (0.224 d^{-1}) were higher than the other treatments. With attention to observed results, corn pollen, sunflower pollen and date pollen were suitable alternative food for the mass rearing of this predator.

Key words: Life table; mass rearing; predatory mite; spider mite eggs; strawberry.

Introduction

The predatory mite, *Neoseiulus barkeri* Hughes (Acari: Phytoseiidae) is a generalist predator, able to develop on a wide range of natural and factitious foods. It is considered one of the most important biocontrol agents of the two-spotted spider mite (Karag *et al*. 1987; Fouly and EL-Laithy 1992; Momen 1995) or other pests such as, *Polyphagotarsonemus latus* (Banks) (Fan and Petitt 1994), *Bemisia tabaci* Gennadius (Nomikou *et al*. 2001), *Thrips tabaci* Lind (Hansen 1988; Bond 1989; Wu *et al*. 2014), *Frankliniella occidentalis* (Pergande) (Ramakers and Van Lieburg 1982), *Stenotarsonemus laticeps* (Halbert) (Messelink and Van Holstein-Saj 2006), *Aleuroglyphus ovatus* Toupeau (Xia *et al.* 2012), *Oligonychus afrasiaticus* (McGreor) (Negm *et al*. 2014). This predatory mite can be fed on plant pollen (Bond 1989). It is widely distributed to all countries (Moraes *et al*. 2004).

Studies are available on different ecological aspects of this predator, including biology (Brodsgarrd and Hansen 1992; Van Houten *et al*. 1995; Negm *et al*. 2014); feeding (Momen 1995); Functional response (Fan and Petitt 1994; Wu *et al*. 2014), biological control (Fan and Petitt 1994), effect of abiotic factors such as temperature on biology and foraging behavior (Bond 1989; Jafari *et al*. 2010, 2012a, b) and its population fluctuation in natural conditions (Jafari *et al*. 2013).

Some of phytoseiid mites utilize pollen as a food source, they develop and reproduce on a pollen diet as well (Tanigoshi *et al*. 1993; Yue and Tsai 1996; Van Rijn and Tanigoshi 1999; Nomikou *et al*. 2003). They require pollen for successful development and reproduction (Addison *et al*. 2000). The nutritional value of pollen varies between plant species and thus the developmental periods and reproductive response of phytoseiid mites on different pollens can also be quite variable (Tanigoshi *et al*. 1993; Von Engel and Ohnesorge 1994; Yue *et al*. 1994; Yue and Tsai 1996). Pollen can be used as a food source for mass rearing or to improve predator efficacy in the field. Several studies were reported the influence of pollen on life history of some phytoseiid mites *i.e.* ice plant pollen on *Euseius mesembrinus* (Dean) (Abou-Setta and Childers 1987); date pollen on *Proprioseiopsis asetus* (Chant) (Fouly 1997); Oak (*Quercus virginiana*) pollen on *Amblyseius largoensis* (Muma) (Carrilo *et al*. 2010); pollen of cumbungi, *Typha orientalis* Presl on *Amblyseius victoriensis* (Womersley) and *Typhlodromus doreenae* Schicha (James and Whitney, 1993) and cattail pollen on *Typhlodromips swirskii* (Athias-Henriot) (Park *et al*. 2011), tea pollen on *Amblyseius sojaensis* Ehara (Osakabe *et al*. 1986), Friut tree pollen on *Euseius stipulates* (Athias-Henriot) (Bouras and Papadoulis 2005), 21- type plant pollens on *T. swirski* (Goleva and Zebit 2013).

In this study, we compared the effects of five pollens as supplementary food sources on life history and intrinsic population growth rate of *N. barkeri.*

Material and methods

Colony – *Neoseiulus barkeri* was collected from cucumber fields of Khoramabad, Lorestan Province of Iran and maintained on leaves of bean which were infested with the two-spotted spider mite. The stock culture of *N. barkeri* was maintained in a growth chamber at 27 ± 1°C, 70 ± 5% RH and 16 L: 8 D hours. The tested pollens were collected by hand (walnut pollen from Tabriz, corn pollen from Karaj, sunflower pollen from Tehran and date pollen from Bam) and by using honey bees (bee pollen). Pollens were stored in the refrigerator during the experiments.

Experiments – Gravid female of the predatory mites were transferred from the main culture onto strawberry leaves and left for 24 hours to oviposit. Only one egg remained on each leaflet and the mite and additional eggs were removed. The leaflet of strawberry leaves (cultivar: Gaviota) (2×2 cm^2) was placed upside down on water saturated cotton in a 6 cm diameter Pteri dish surrounded by strips of wet cotton wool to prevent the mites from escaping. Leaves of strawberry were provided with sufficient amount of each plant pollen and *T. urticae* eggs separately and replaced with them daily. When an individual developed to the adult stage, it was paired with an individual of the opposite sex to obtain the cohort individuals. The duration of developmental stages of the predator was recorded at 24-hour intervals. The oviposition rate of *N. barkeri* was recorded daily. Each test was continued until all individuals died and for each diet 70–100 individuals were tested.

Statistical analysis – Developmental times of all individuals, including male and female and those who died before adult stage and female daily fecundity were subjected to analysis of variance. The life tables of the predator were constructed based on two-sex life table (Chi 2005). The population parameters were estimated based on Chi & Liu's model (1985), using data of both sexes and the variable developmental rate among individuals. The age-stage specific survival rate (s_{xj}, where x = age and j = stage), the age-specific survival rate (l_x), the age specific fecundity (m_x), the age-stage specific fecundity (f_x) and the population parameters (r (intrinsic rate of increase), λ (finite rate of increase; $\lambda = e^r$), R_0 (net reproduction rate), and T (the mean generation time) were calculated using TWO SEX-MSChart program (Chi 2005). Developmental times, adult life span and fecundity rates were analyzed using ANOVA (SPSS Inc. 2012). The mean generation time was defined as the duration that a population needs to increase to R_0-fold of its size to reach stable age distribution and stable increase rate. Intrinsic rate of increase was estimated using the iterative bisection method from the Euler-Lotka formula with age indexed from 0 (Goodman 1982).

Bootstrap technique was used to estimate variances and standard errors of the population parameters. In our study, 10000 replications were used (Huang and Chi 2013), because bootstrapping uses random re-sampling and if a small number of replications were used, it would result in variable means and standard errors which could end up in unreliable results. Multiple comparison tests among treatments were conducted in Kruskalmc program. The graphs were produced usig SigmaPlot software (ver. 12.0) (Sigmaplot 2011).

Results

Neoseiulus barkeri completed its development on five pollens (walnut, corn, sunflower, bee and date pollen) and *T. urticae* eggs. The developmental times and reproduction rate are given in Table 1. Total mortality of immature *N. barkeri* on different plant pollens (sunflower, bee, corn, date and walnut pollen) were 14%, 29%, 10%, 16% and 21%, respectively. The duration of all developmental stages of *N. barkeri* was affected by different diets. A significant difference was observed in the egg incubation period. The highest developmental time was observed on bee pollen and sunflower pollen for larval and nymphal stages. The adult longevity of *N. barkeri* on bee pollen was higher than the other diets. In this study, the shortest adult longevity of *N. barkeri* was reported on sunflower pollen. The preoviposition period of *N. barkeri* on different pollens showed significant difference (Table 1), however, the oviposition rate of predatory mite did not show any significant difference. The life time longevity of mites did not show any significant difference among five diets. Estimated significant parameters of the life table for *N. barkeri* on different plant pollens are listed in Table 2. The intrinsic rate of increase of the predatory mite fed with *T. urticae* eggs and date pollen, sunflower pollen and corn pollen (0.225, 0.212, 0.224 d^{-1}) were higher than the other treatments.

The age-stage survival rate (s_{xj}) of *N. barkeri* is given in Figure 1. This curve shows the probability that a newly hatched mites will survive to age x and stage j. The survival curve of cohort usually shows significant stage overlapping because of the variable developmental rates among individuals. This curve show the survivorship and stage differentiation rate of *N. barkeri* on different diets. The life expectancy of newly hatched egg of *N. barkeri* on five diets were 14, 13.8, 14, 14 and 13 days on sunflower pollen, bee pollen, corn pollen, date pollen and walnut pollen respectively as shown in Figure 2. The age-specific survival rate (l_x), the age-specific fecundity (m_x) and the age-stage specific fecundity (f_x) are shown in Figure 3.

Table 1. Life history statistics (Mean ± SE) of *Neoseiulus barkeri* on different plant pollens and *Tetranychus urticae* eggs.

Developmental time	Corn pollen & spider mite	Bee pollen & spider mite	Walnut pollen & spider mite	Sunflower pollen & spider mite	Date pollen & spider mite	df	F	P
Egg	1.92 ±0.06 ^{a}	1.77 ± 0.08 ^{a}	1.40 ± 0.08 ^{b}	1.46 ± 0.06 ^{b}	1.39 ± 0.07 ^{b}	282	12.03	0.0001
Larva & nymph	3.57 ± 0.09 ^{b}	4.57 ± 0.15 ^{a}	3.62 ± 0.08 ^{b}	4.41 ± 0.10 ^{a}	3.54 ± 0.10 ^{b}	268	18.92	0.0001
Adult longevity								
Female	9.59 ± 0.24 ^{b}	10.0 ± 0.18 ^{a}	11.15 ± 0.56 ^{b}	9.24 ± 0.19 ^{b}	12.12 ± 0.66 ^{b}	166	11.42	0.0001
Male	4.75 ± 0.97 ^{b}	9.25 ± 0.25 ^{a}	8.5 ± 0.2 ^{b}	6.94 ± 0.19 ^{b}	8.67 ± 0.19 ^{b}	67	17.85	0.0001
Preoviposition period								
APOP†	1.24 ± 0.08 ^{b}	1.57 ± 0.09 ^{b}	1.20 ± 0.09 ^{b}	1.09 ± 0.05 ^{b}	1.32 ± 0.09 ^{a}	161	4.61	0.0015
TPOP††	6.61 ± 0.15 ^{b}	8.21 ± 0.23 ^{b}	6.35 ± 0.19 ^{b}	6.86 ± 0.19 ^{b}	5.96 ± 0.17 ^{a}	161	16.58	0.001
Lifetime fecundity	14.51 ± 0.78 ^{b}	14.61 ± 0.6 ^{b}	13.25 ± 0.42 ^{b}	13.69 ± 1.00 ^{b}	15.32 ± 0.96 ^{b}	166	0.63	0.64
Lifetime longevity	14.13 ± 0.36 ^{b}	13 ± 0.74 ^{b}	12.75 ± 0.8 ^{b}	13.12 ± 0.43 ^{b}	13.93 ± 0.78 ^{b}	282	0.95	0.43

Means within a row followed by the same letter are not significantly different at the 5% confidence level accrding to ANOVA test.
† APOP (Preoviposition period of female)
†† TPOP (Total preoviposition period of female counted from birth)

Table 2. Mean ± SE of life table parameters of *Neoseiulus barkeri* on different plant pollens and *Tetranychus urticae* eggs

Life table parameters	Plant pollens	Mean ± SE	CI			
			Corn pollen	Date pollen	Walnut pollen	Sunflower pollen
Intrinsic rate of increase (r) (day $^{-1}$)	Date pollen	0.225 ± 0.016	(−0.017–0.056)$^{n.s}$			
	Sunflower pollen	0.212 ± 0.012	(0.003–0.061)*	(−0.03–0.06)$^{n.s}$	(−0.027–0.099)$^{n.}$	
	Walnut pollen	0.172 ± 0.018	(0.032–0.113)*	(0.059–0.123)*		
	Bee pollen	0.159 ± 0.014	(0.054–0.117)*	(0.029 ± 0.131)*	(0.022 ± 0.105)*	(−0.032–0.057) *
	Corn pollen	0.224 ± 0.008			(−0.037–0.068)$^{n.}$	
Finite rate of increase (λ)(day^{-1})	Date pollen	1.252 ± 0.021	(−0.02–0.07)$^{n.s}$			
	Sunflower pollen	1.236 ± 0.014	(0.005–0.077)*	(−0.03–0.06)$^{n.s}$		
	Walnut pollen	1.188 ± 0.022	(0.040–0.137)*	(0.059–0.123)*	(−0.037–0.068) *	(−0.027–0.099)$^{n.s}$
	Bee pollen	1.172 ± 0.016	(0.067–0.143)*	(0.029 ± 0.131)*		(0.022 ± 0.105)*
	Corn pollen	1.277 ± 0.011			(−0.037–0.068)$^{n.}$	
Net reproductive rate (R_0) (offspring/ individual)	Date pollen	8.710 ± 1.269			(−0.243–6.046)$^{n.}$	
	Sunflower pollen	8.823 ± 0.012	(0.143–5.520)*	(−3.024–3.25)$^{n.s}$	(0.167 ± 5.761)*	
	Walnut pollen	5.859 ± 1.041				
	Bee pollen	6.693 ± 0.974	(2.278–7.643) *	(−1.126–5.160) $^{n.s}$	(-1.950–3.619)$^{n.s}$	(−0.574–4.834) $^{n.s}$
	Corn pollen	11.654 ± 0.956		(−0.149–6.036)$^{n.s}$	(3.032±8.558)*	
Mean of generation time (T) (day)	Date pollen	9.572 ± 0.159	(−0.017–0.056)$^{n.s}$			
	Sunflower pollen	10.237 ± 0.221	(−0.337–0.793)$^{n.s}$	(0.129 ± 1.202)*	(−0.567–0.067)$^{n.}$	
	Walnut pollen	10.186 ± 0.227	(−0.43–0.744)$^{n.s}$	(0.075 ± 1.153)*		(−0.027–0.099)$^{n.s}$
	Bee pollen	11.901 ± 0.225	(1.285–2.459)*	(1.787 ± 2.871)*	(1.0845 ± 2.347)	(1.042 ± 2.285)*
	Corn pollen	10.029 ± 0.196		(−0.038–0.953)$^{n.s}$	(−0.037–0.068)$^{n.}$	

Multiple comparison tests among treatments were conducted in Kruskalmc program. When there is zero in data range (CI), two treatments were not significantly different.

Discussion

Neoseiulus barkeri was able to develop and reproduce when fed on five diets (date pollen + egg of *T. urticae,* walnut pollen + egg of *T. urticae,* corn pollen + egg of *T. urticae,* bee pollen + egg of *T. urticae,* and sunflower pollen + egg of *T. urticae*). We compared five pollen species that may serve as food sources. The quality of food may determine the developmental time and reproductive characteristics of the predatory mite (Moraes and McMurtry 1985). Some researchers studied about the effect of different types of food on biological parameters of *N. barkeri* (such as Bond 1989; Jafari *et al.* 2010; Xia *et al*. 2012; Negm *et al*. 2014).

The most eggs used in this study successfully hatched (96%, 92%, 100%, 93%, 93% when fed on sunflower, bee, corn, date and walnut pollens plus *T. urticae* eggs). The highest mortality at the immature stage was on bee pollen (21%) and the lowest immature stage mortality was on date pollen (9%). Ragusa *et al*. (2009) showed that 84% of egg of *N. californicus* reached the adulthood when feed on pollen of *Carpobrotus edulis* (L.) and *Scrophularia peregrina* L.

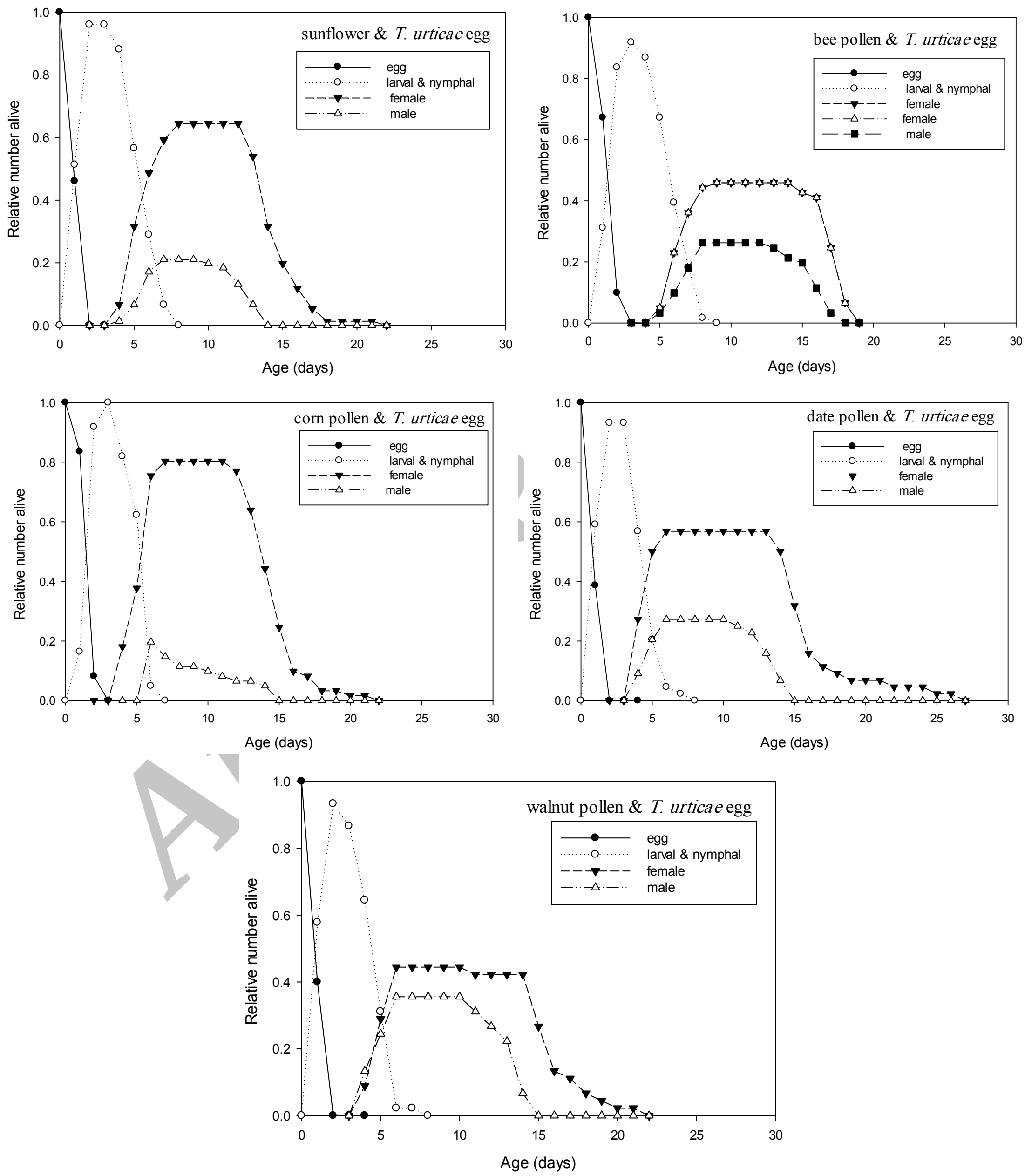

Figure 1. Relative number of live individuals in each age-stage group (s_{xj}) of *Neoseiulus barkeri* on different plant pollens and *Tetranychus urticae* eggs.

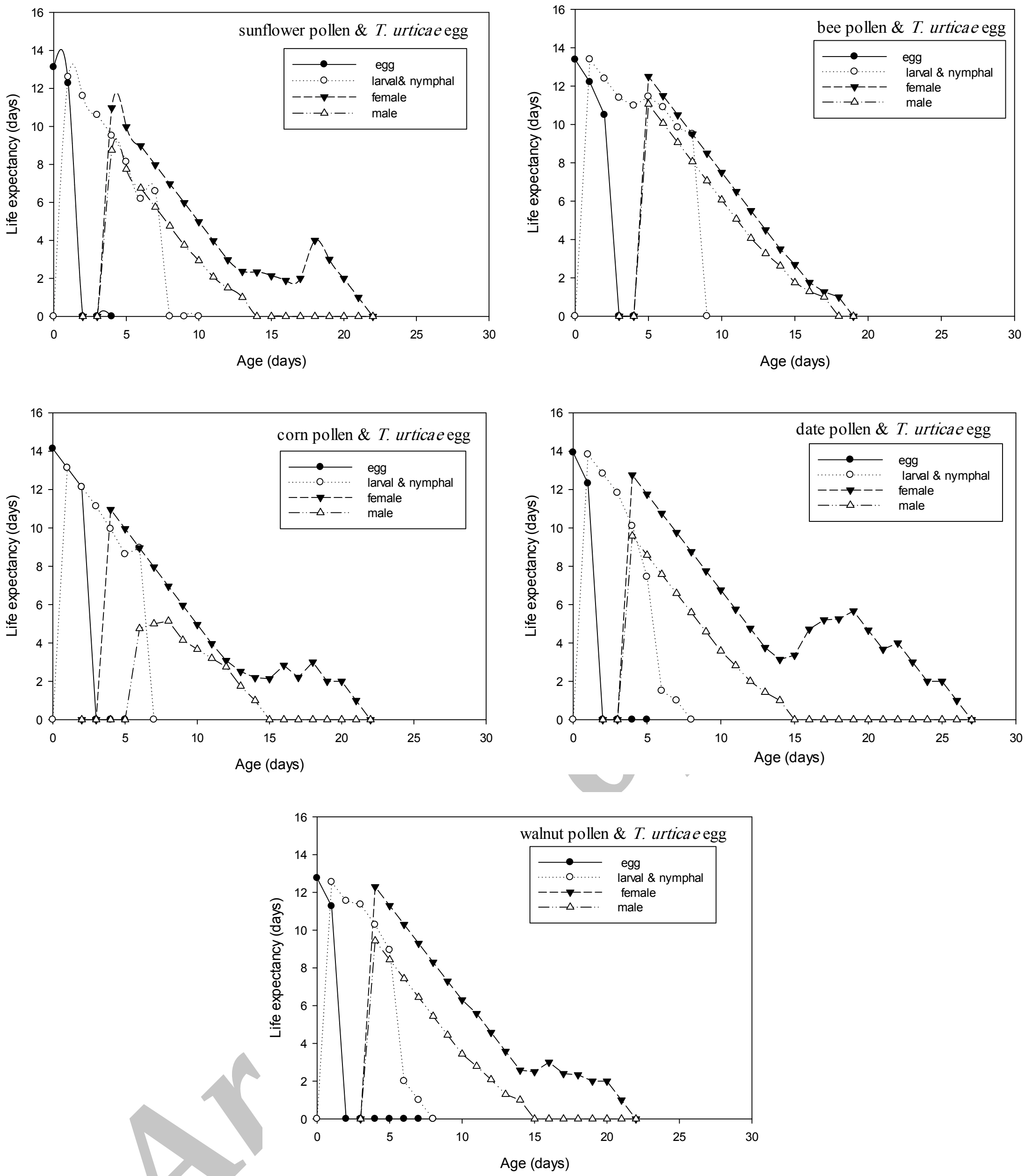

Figure 2. Life expectancy in each age-stage group (e_{xj}) of *Neoseiulus barkeri* on different plant pollens and *Tetranychus urticae* eggs.

The egg incubation periods of *N. barkeri* varied between 1.39–1.92 days. Development of *N. barkeri* immature period varied between (3.54–4.57 days) on five diets. On the other hand, this developmental period was relatively shorter in our study than reported when fed on *O.atrasiaticus* (9.6 days at 25°C) (Negm *et al*. 2014) or when fed with *A. ovatus* (7.8 days at 24°C) (Xia *et al.* 2012) and Jafari *et al.* (2012) showed that developmental time of immature stages was 5.68 days when fed on *T. tabaci* and developmental time *N. barkeri* immature recorded by Bond (1989) (6.2 days) and Beglyarov & Suchalkin (1983) (5.98 days) fed on *T. tabaci*. This parameter for this population of *N. barkeri* fed on *T. urticae* (all developmental stages) was 3.67 days

(Rezaie and Javan Nezhad 2016) and recorded by Jafari *et al.* (2012) (4.59 days). This difference could be due to differences in laboratory condition or prey species. The mean developmental times of *Iphiseius degenerans* (Berlese) on different tested pollens ranged from 4.0 to 7.1 days, with the lowest value recorded on almond pollen and the highest on sweet pepper pollen (Vantornhout *et al*. 2005).

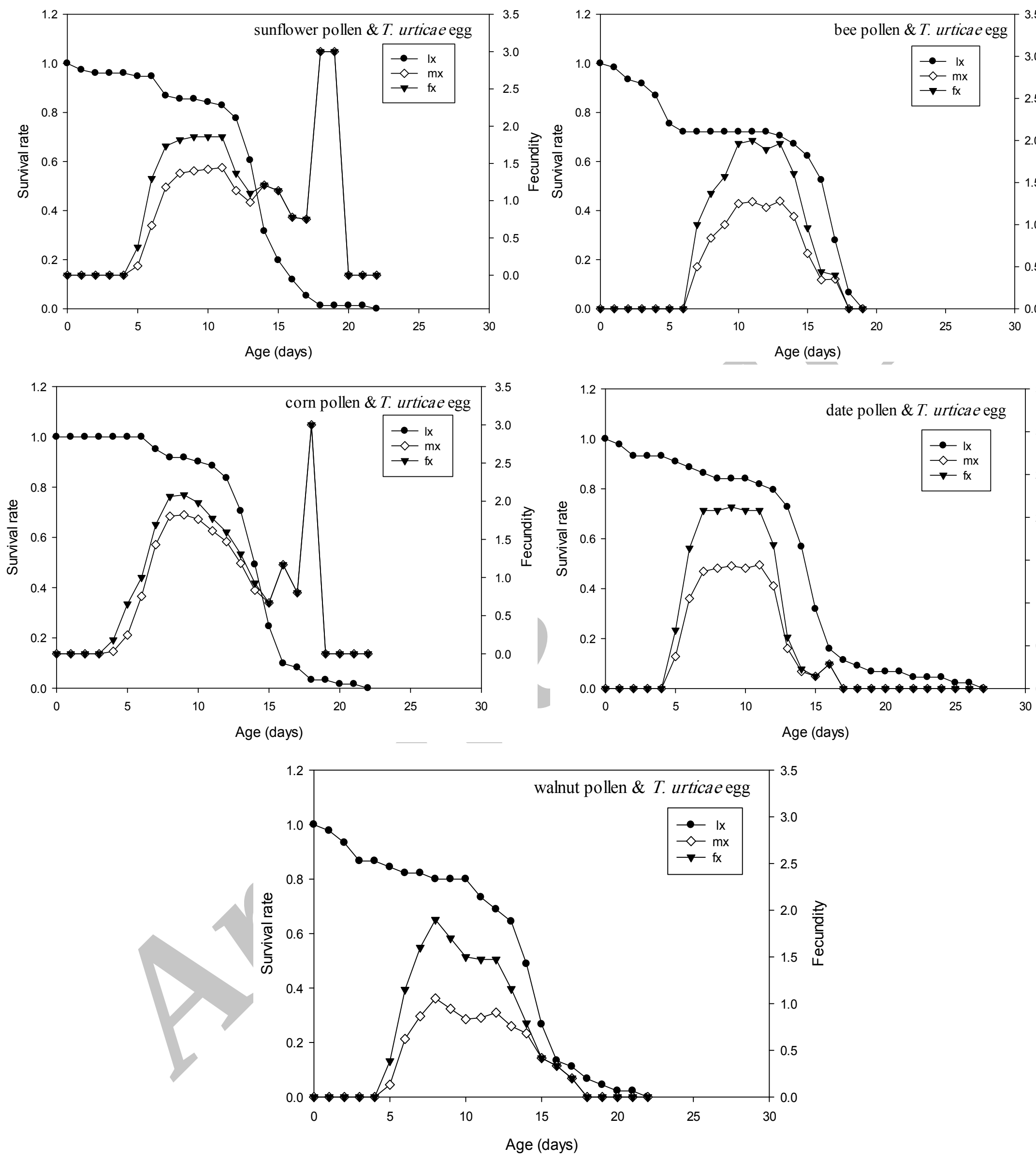

Figure 3. Age-specific survival rate (l_x), age-specific fecundity of the total population (m_x) and female age-specifc fecundity (f_x) of *Neoseiulus barkeri* on different plant pollens and *Tetranychus urticae* eggs.

The adult longevity (female) of *N. barkeri* was different among diets and varied between (9.24–12.12 days), however, the male longevity of predatory mite was different and varied between (4.75–9.25 days) on five diets. Female longevity of *N. barkeri* on *O. afrasiaticus* was 27.4 days (Negm *et al*. 2014). The adult longevity in the previous study on *T. urticae* was 19 days and on *T. tabaci* was 13.25 days (Rezaie and Javan Nezhad 2016), however, this parameter is shorter than that reported by Jafari (2011, 2013) as 20.17 days fed on *T.tabaci* and 25.45 days fed on *T. urticae.* Female longevity of *N. barkeri* on *O. afrasiaticus* was 27.4 days (Negm *et al*. 2014).

The sex ratio of *N. barkeri* in the present study was female biased (on sunflower pollen 75%, bee pollen 63%, corn pollen 80%, date pollen, 67%, walnut pollen, 55%). Similarly Momen (1995) reported the female ratio of *N. barkeri* on *T. urticae* was as 60%. In another study, Xia *et al.* (2012) reported the sex ratio for this predator was 60.87%. Jafari *et al*. (2010) reported this parameter for *N. barkeri* fed on *T. urticae* was 60%. The sex ratio in the previous study was female biased (on *T. urticae* (68%), on *T. tabaci* (65%) and the sex ratio of the predatory mite on corn pollen is male dominat (Rezaie and Javan Nezhad 2016). In another study, Jafari *et al*. (2013) reported the sex ratio for this predator to be 61.66% fed on *T. tabaci*. Based on Palevsky *et al*. (1999) the progeny sex ratio is male dominant, when prey is rare. In phytoseiid mites the sex ratio is usually female dominant (Amano and Chant 1977; Tanigoshi 1982; Sabelis 1985). Female phytoseiid mites require multiple matings to reach full reproductive potential (Amano and Chant 1977). In this study, the progeny sex ratio was female dominant on all diets.

Rugusa *et al.* (1995) was reported that female usually lay eggs only on food considered adequate for postembryonic development of the progency. Jafari *et al.* (2013) reported daily and total fecundity of *N. barkeri* as 2.48 eggs/female/day and 36.40 eggs/female respectively. In another study, Bond (1989) reported daily and total fecundity of this predator as 2.3 eggs/female /day and 47.1 eggs/female on *T. tabaci* at 25°C. Jafari *et al.* (2010) was reported 2.57 eggs/female/days and 38.62 eggs/female respectively fed on *T. urticae*. The oviposition rate was 34.8 eggs/female (Negm *et al.* 2014). In the present study, the life time fecundity of *N. barkeri* on different plant pollens did not show any significant difference and ranged between 13.25–15.32 eggs/female. This difference could be due to difference in laboratory condition or predator strain or type of prey. *Typhlodomus pyri* Scheuten deposited an average 15 and 4 eggs feeding on hollyhock and cotton pollen, respectively (Zaher and Shehata 1971).

The *r* value is most important intrinsic parameters that indicate the potential of predator for growth, reproduction and survival (Southwood 1986). This parameter is the most important population growth parameter (Southwood and Handerson 2000). The population growth parameters of *N. barkeri* in present study varied in response to changing in plant pollen. The *r* value of *N. barkeri* in the present study on different plant pollen show significant difference and the highest value was observed when the predator fed on corn pollen or date pollen. The mean generation time of *N. barkeri* was higher when fed on bee pollen. Several researchers have demonstrated that type of prey affect on life parameters of phytoseiid mites. The life table parameter (R_0, T, r) value were 27.78, 19.10, 0.22 respectively (Bond 1989) and on *A. ovatus* at 24°C, the parameter value were 20.14, 20.07, 0.14 (Xia *et al*. 2012) and on *T. urticae* were 22.02, 13.95, 0.22 (Jafari *et al*. 2012). The *r* value of *N. barkeri* on *O. afrasticus* was 0.16 day^{-1} (Negm *et al*. 2014), on *A. ovatus* was 0.17 day^{-1} (Xia *et al*. 2012). The *r* value of this predator on *T. tabaci* was 0.252 day^{-1} (Jafari *et al*. 2013). The intrinsic rate of increase (*r*) of the predatory mite *T. swirskii* was 0.185 day^{-1} and 0.201 day^{-1} on the cattail pollen and *Aculops lycopersici* (Mossee) respectively (Park *et al.* 2011). The *r* value of *Amblydromalus limonicus* Garman and McGregor on cattail and olive pollen resulted 0.234, 0.200 day^{-1} (Samaras *et al*. 2015)

Some phytoseiid mites require pollen for successful development and reproduction (Addison *et al*. 2000). Pollen is utilized as an easy food source to rear phytoseiid mites (McMurtry and Scriven 1965).The morphology of the pollen grains will greatly affect case of handling. The nutritional value of pollen varies across plant species and thus the developmental and reproductive response of phytoseiid to different pollens can also be quite variable (Tanigoshi *et al*. 1993; Yue *et al*. 1994; Von Engel and Ohnesorge 1994; Yue and Tsai 1996). The phytoseiid mites are able to develop and reproduce when fed plant pollen*, e.g.* Almond, palm, cherry and apricot pollen possess higher nutritional value for *E. stipulates* (Bouras and Papadoulis 2005). *Typhlodomus pyri* can feed and reproduces on pollen from a variety of plants (Van Engel and Ohnesorage 1994). *Euseius gossipi* (Elbadry) developed and reproduced readily on the pollen of *Zea mays* L. and *Phoenix dactylifera* L. (Elbadry and Elbenhauy 2011). Pollen of cumbungi, *Typha orientalis*, was used successfully as a laboratory diet for arena based cultures of *Eueius victoriensis* (Womersley) and *Typhlodromus doreenae* Schicha (James and Whitney 1993). Pollen of *Ricinus communis* (Castor) and *Z. mays* can be recommended as supplementary food (Goleva and Zebitz 2013). Some phytoseiid mites, *I. quadripilis* (Banks), *Typhlodromalus peregrines* (Muma) can be reared in the laboratory on an exclusive diet of pollen from the ice plant, *Malephora Jacquin* (Jacquim) (Villanueva and Childers 2006). Some researchers investigated the biological parameters the phytoseiid mites when fed plant pollen compared to fed spider mite *e.g.* Khodayari *et al*. (2013) showed that corn pollen compared the spider mite prey, so the food source increased the juvenile developmental time and decreased the longevity and fecundity of adult female of *Phytoseius plumifer* (Canestrini and Fanzago), although the predators could develop and reproduce successfully. Van Rijn *et al.* (1999) was reported that bee-collected pollen readily absorbed water from the air and lost its food value after one or two days. In this study, bee pollen, among other treated pollen was not sutiable for the predatory mite.

Villanueva and Childeres (2006) was reported that a positive correlation was found between number of phytoseid and number of pollen grains on grapefruit leaves. The presence of weed and their pollen in citrus groves increase their effectiveness of *T. swirskii* (Ragusa 1991).

Some pollen are not suitable for the phytoseiid mite, *e.g. E. stipulates* was unable to reproduce when feeding on walnut pollen (Bouras and Papadoulis 2005). Zaher *et al*. (1971) was reported that *P. plumifer* could develop and reproduce successfully on date pollen, but at a slower rate. *Typhlodomips swirskii* can not be completed developmental time when fed on bee pollen (Goleva and Zebit 2013).

With attention to observed results, *N. barkeri* is a general predator and can play an important role in the biological control of *T. urticae*. The predatory mite with feeding on corn pollen, walnut pollen, date pollen, sunflower pollen and bee pollen can complete the developmental stages and can oviposit. Corn pollen, sunflower pollen and date pollen were suitable alternative food for the mass rearing of this predator.

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تـاثیر تغذیـه بـا دانـهٔ گـرده‌هـای مختلـف بـر آمـاره‌هـای جـدول زنـدگی کنـهٔ *Neoseiulus barkeri* Hughes (Acari: Phytoseiidae)

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چکیده

کنه *Neoseiulus barkeri* Hughes از مهم‌ترین شکارگرهای خانوادهٔ Phytoseiidae است. در این پژوهش تاثیر رژیم‌های غذایی مختلف شامل گرده‌های گیاهان مختلف ذرت، خرما، آفتابگردان، گردو و گرده جمع‌آوری شده توسط زنبور عسل به علاوهٔ تخم کنهٔ تارتن دو لکه‌ای در شرایط آزمایشگاهی (دمای ۱±۲۷ درجهٔ سلسیوس، دوره روشنایی: تاریکی ۸:۱۶ و رطوبت ۵±۷۰ درصد) روی آماره‌های مختلف جدول زندگی مورد مقایسه قرار گرفت. از دیسک‌های برگی از گیاه توت فرنگی روی اسفنج مرطوب در تشتک پتری استفاده شد. این کنهٔ شکارگر از مزارع خیار آلوده به کنهٔ تارتن دو لکه‌ای از شهرستان خرم‌آباد، استان لرستان جمع‌آوری شد. نتایج آزمایش‌ها نشان می‌دهد که طول دوره زیستی مراحل نابالغ این کنه در صورت تغذیه با گرده آفتابگردان و گرده زنبور عسل به طور معنی‌داری طولانی‌تر از طول مراحل زیستی پیش از بلوغ کنهٔ شکارگر در صورت تغذیه از دیگر گرده‌های مورد آزمون است. طول دوره زیستی مراحل بالغ کنهٔ *N. barkeri* هم در صورت تغذیه با گردهٔ زنبور عسل (به ترتیب ۱۰ و ۹/۲۵ روز برای افراد ماده و نر) طولانی‌تر از طول عمر کنه‌هایی است که از دیگر گرده‌های مورد آزمون تغذیه کرده‌اند. تعداد نتاج تولید شده به ازای هر فرد ماده در صورت تغذیه افراد با رژیم‌های غذایی متفاوت با یکدیگر اختلاف معنی‌داری را نشان نمی‌دهد. میزان ذاتی افزایش جمعیت (r) در صورت تغذیه از گردهٔ آفتابگردان (۰/۲۱۲ روز$^{-1}$)، گردهٔ خرما (۰/۲۲۵

روز$^{-1}$) و گردهٔ ذرت (۰/۲۲۴ روز$^{-1}$) به طور معنی‌داری بیشتر از میزان ذاتی در صورت تغذیه از دیگر گرده‌های مورد آزمون بود. بر این اساس *N. barkerii* به عنوان شکارگر عمومی نقش مهمی در کنترل بیولوژیک کنهٔ تارتن دو لکه‌ای دارد. گردهٔ ذرت، گردهٔ خرما و گردهٔ آفتابگردان به عنوان غذایی مناسب مکمل برای پرورش انبوه این شکارگر قابل استفاده است.

واژگان کلیدی: جدول زندگی؛ پرورش انبوه؛ کنهٔ شکارگر؛ تخم‌های کنهٔ تارتن؛ توت‌فرنگی.

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