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Article

Life table parameters of *Tetranychus kanzawai* Kishida (Acari: Tetranychidae) on six red bean genotypes

Saba Sepahvandian[1], Shahriar Jafari[1*], Amir Mohseni Amin[2] and Jahanshir Shakarami[1]

1. *Department of Plant Protection, Faculty of Agriculture, Lorestan University, P.O. Box: 465, Khorramabad, Iran; E-mails: saba.sepahvandian@gmail.com, Shahriar.jafari@gmail.com & Jafari.s@lu.ac.ir, shakarami.j@lu.ac.ir*
2. *Borujerd Agricultural Research and Education Campus, Lorestan Agricultural and Natural Resources Research and Education Center, AREEO, Borujerd, Iran; E-mail: a.mohseni@areeo.ac.ir*

[*] Corresponding author

ABSTRACT

Tetranychus kanzawai Kishida (Acari: Tetranychidae) is considered an important pest of different crops; its damage significantly has increased in recent years in some regions of Iran. The life history parameters of *T. kanzawai* on six red bean genotypes (KS31288, KS31292, KS31287, KS31285, Akhtar and Goli) at 28 ± 1 ºC, 50 ± 10% RH and a photoperiod of 16:8 (L: D) h were studied. The life table was constructed considering the female characters of the studied cohort. The developmental time of *T. kanzawai* differed among tested genotypes and ranged from 8.50 days on KS31285 to 9.77 days on KS31292. The highest and lowest value of immature survival rate were 0.85% on KS31285 and 0.77% on KS31287, respectively. The total fecundity varied significantly on different genotypes, being the highest on KS31288 (71.40 eggs) and the lowest on Akhtar (19.44 eggs). The mean generation time (T) was shortest on Akhtar (8.54 days) and longest on KS31288 (12.09 days). The lowest intrinsic rate of natural increase (r_m) was recorded on KS31287 (0.229 day^{-1}) and the highest values of this parameter were obtained on KS31288 (0.303 day^{-1}). According to our results, KS31288 and KS31287 were partially susceptible and resistant genotypes to *T. kanzawai*, respectively. The findings of this study provide new insights to design a more comprehensive pest management program for this pest.

KEY WORDS: Antibiosis resistance; bean genotypes; female; Kanzawa spider mite; life history.

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INTRODUCTION

Common bean (*Phaseolus vulgaris* L.) is commercially produced in some regions of Iran. This crop is grown on more than 105000 ha annually in Iran, with Fars, Khuzestan, Lorestan, Zanjan and Markazi provinces having the most bean cultivated area, respectively (Statistical Bulletin 2014). Among different pests that have negative effects on this crop, spider mites, and onion thrips, *Thrips tabaci* Lindeman (Thysanoptera: Thripidae) are noticeable (Roozbahani *et al*. 2016). The Kanzawa spider mite, *Tetranychus kanzawai* Kishida, is an important pest threatening many agricultural crops including apple, prune, eggplant, soybean, tea and bean as well as some ornamental plants (Gotoh and Gomi 2000; Beyzavi *et al*. 2013).

Spider mites are mainly controlled by chemical acaricides, but rapid developmental rate, short life span and high fecundity and also ability of these phytophagous pests to develop resistance to many acaricides have made the chemical control of these mites particularly difficult (Luczynski *et al.* 1990; Jafari *et al*. 2010). Furthermore, with regards to negative effects of chemical pesticide on environmental pollution, natural enemies and no target organisms, use of safe methods to control these main pests are necessary. Host-plant resistance is a useful component of integrated pest management (IPM) programs that with other safe methods can be used to maintain spider mite populations under the economic levels.

It is well known that variation in plant properties influences life history parameters of phytophagous arthropods (Darvishzadeh and Jafari 2016). Studying of potential resistance by comparing pest performance on different genotypes is an important step to identify potential antibiosis compounds for further use in pest management programs (Fathipour and Naseri 2011). The difference in response of different cultivars of bean to *T. urticae* (Ahmadi *et al.* 2007; Modarres Najafabadi 2012; Modarres Najafabadi *et al*. 2014; Uddin *et al*. 2015), *Thrips tabaci* Lindeman (Roozbahani *et al*. 2016) and *Spodoptera exigua* (Hubner) (Lepidoptera: Noctuidae) (Mehrkhou *et al*. 2012) was studied.

The aim of this study was to evaluate the antibiosis effects of six red bean genotypes on life table parameters of *T. kanzawai*, determine the resistant genotypes and introduce them for use in integrated management of this pest in future.

MATERIAL AND METHODS

Plant culture

Seeds of six commercial red bean (*Phaseolus vulgaris* L.) genotypes were obtained from the Agricultural and Natural Resources Research and Education Center of Lorestan, Boroujerd Campus, Boroujerd, Iran. The tested genotypes with their codes were: Goli/NAZ/Goli (KS31288), AND1007/D81083 (KS31292), KS31169 (KS31287), D81083/AND1007 (KS31285), Akhtar and Goli (Goli). The genotypes were grown individually in 20 cm diameter plastic pots on a mixture of soil, sand and manure vermicompost (4:2:1) in a greenhouse at 27 ± 5 ºC, 50 ± 10% RH and a photoperiod of 12:12 (L: D) h. No insecticides or fertilizers were applied to the plants. Fresh leaves of grown plants, i.e. with more than five true leaves, were used for the experiments.

Mite rearing

Approximately 350 adults of *T. kanzawai* (female and male) were originally collected from infested weeds at the Faculty of Agriculture of Lorestan University, Western Iran, in summer 2016 and transferred to the laboratory. In laboratory, the collected individuals were used to establish stock colony, therefore divided into six groups and transferred on different bean genotypes. These mites were reared for two generations on each genotype before being used in the experiments. Rearing mites was performed at 28 ± 1 ºC, 50 ± 10% RH and a photoperiod of 16 L: 8D h.

Experiments

Experiments were carried out using arenas consisting of a piece of bean leaf (2.5 cm in diameter), which was placed upside down inside plastic Petri dishes (6 cm in diameter). To keep the leaves fresh, these arenas were placed in cotton moist with water. The mites were transferred to new arenas every 3 or 4 days. To determine the developmental time, a cohort consisting of 70 same-aged eggs was used. The new mated females were transferred to 70 new experimental units and after 12 h the females and surplus eggs were removed; only one egg remained in each unit and monitored during the developmental time. To determine the duration of the immature stages of *T. kanzawai*, inspections were carried out twice daily under a stereomicroscope until the mites reached adulthood. Duration of immature stages of both female and male was recorded on the six bean genotypes at 28 ± 1°C with 50 ± 5% RH and a photoperiod of 16: 8 h (L: D).

To study the adult characters of mite on each genotype, newly emerged females that developed in the previous experiments were coupled with males obtained in the experiment or taken from the stock colony on the same genotypes. The experimental units were monitored twice daily and any changes recorded until the death of the last female. This monitoring allowed us to determine the parameters of survival, pre-oviposition, oviposition, and post-oviposition periods, female and male longevity and fecundity. Age-specific survival rates or survivorship (l_x) of all stages of mite for each experimental genotype were calculated according to Carey (1993) equations. The life table was constructed considering the female characters of the studied cohort. Using life and fertility tables, population growth parameters including the net reproductive rate (R_0), mean generation time (T), doubling time (DT), intrinsic rate of natural increase (r_m) and finite rate of increase (λ) were calculated using the methods recommended by Birch (1948). Calculation of a corrected r_m value was performed by iteration. The method, aiming to find r_m for which $(1 - \Sigma\exp(-r_m \times x) \times lx \times m_x)$ is minimal, was given by Maia *et al*. (2000).

Data analysis

Statistical differences in demographic parameters were tested using Jackknife procedure to estimate the variance of the demographic parameters (Meyer *et al*. 1986). The influence of different genotypes on the developmental time, adult longevity and fecundity of *T. kanzawai* was analyzed using one-way analysis of variance (ANOVA). If a significant difference was detected, the Tukey multiple range test was applied to separate the means (P < 0.05). The ANOVA and post-hoc comparisons were carried out using SAS software (Proc GLM, SAS Institute 2003).

RESULTS

Developmental time

Our results declared that *T. kanzawai* on all tested bean genotypes successfully developed to adulthood. The effect of tested bean genotypes on incubation ($F_{5, 217} = 7.69$; $P < 0.01$), protonymphal ($F_{5, 217} = 2.28$; $P = 0.048$), deutochrysalis ($F_{5, 217} = 2.64$; $P = 0.024$), theliochrysalis ($F_{5, 217} = 4.93$; $P < 0.01$) and total immature ($F_{5, 217} = 19.29$; $P < 0.01$) periods of the females was significant (Table 1). But this effect on larval ($F_{5, 217} = 0.92$; $P = 0.471$), protochrysalis ($F_{5, 217} = 0.77$; $P = 0.574$) and deutonymphal ($F_{5, 217} = 0.62$; $P = 0.685$) periods was not significant. The longest and shortest immature developmental times of females were found on KS31292 (9.77 days) and KS31285 (8.50 days), respectively. Also, the effect of tested bean genotypes on incubation ($F_{5, 81} = 4.19$; $P < 0.01$), deutonymphal ($F_{5, 81} = 2.67$; $P = 0.026$) and total immature ($F_{5, 81} = 3.81$; $P < 0.01$) periods of the male individuals was significant. But its effect on larval ($F_{5, 81} = 1.11$; $P = 0.360$), protochrysalis ($F_{5, 81} = 1.27$; $P = 0.286$), protonymphal ($F_{5, 81} = 1.34$; $P = 0.258$), deutochrysalis ($F_{5, 81} = 2.27$; $P = 0.056$) and theliochrysalis ($F_{5, 81} = 1.81$; $P = 0.120$) periods of males was not significant (Table 1).

Survival rate, adult longevity, and fecundity

Survival rate percentage for immature stages of *T. kanzawai* reared on six bean genotypes is presented in Table 2. As shown, survival rate of immature stages (from egg to adult) on all red bean genotypes was higher than 0.77%. Survival rate of immature stages was highest on KS31285, followed by Akhtar, Goli, KS31288, KS31292, and KS31287. The age-specific survivorship curves (l_x) of the *T. kanzawai* on six bean genotypes are shown in figure 1. Results show that death of the last female (maximum age) on KS31292, KS31287, KS31285, Goli, KS31288, and Akhtar occurred at the age of 15, 14, 9, 16, 16 and 15$^{\text{th}}$ days, respectively (Fig. 1).

Also, the mean adult longevity, life span and oviposition period, fecundity and sex ratio of females are shown in Table 2. A significant difference was observed in female longevity ($F_{5, 173} = 7.56$; $P < 0.01$) of *T. kanzawai* (Table 2). The longest and shortest values of adult longevity were recorded on KS31288 (10.10 days) and KS31285 (5.44 days), respectively.

Table 1. Mean (± SE) developmental time (day) of *Tetranychus kanzawai* (female and male) on six red bean genotypes at 28 ± 1 ºC.

Immature stages	Bean genotypes					
Female	**KS31288**	**KS31292**	**KS31287**	**KS31285**	**Goli**	**Akhtar**
Egg	3.65 ± 0.07 bc	4.06 ± 0.09 a	3.61 ± 0.08bc	3.40 ± 0.07c	3.51 ± 0.08bc	3.76 ± 0.06ab
Larva	0.98 ± 0.06 a	0.96 ±0.04a	0.93 ± 0.05a	0.86 ± 0.03a	0.88 ± 0.03a	0.96 ± 0.06a
Protochrysalis	0.78 ± 0.05 a	0.86 ± 0.03 a	0.81 ± 0.4a	0.81 ± 0.03a	0.89 ± 0.05a	0.82 ± 0.03a
Protonymph	0.87 ± 0.03 ab	0.98 ± 0.04 a	0.83 ± 0.05ab	0.88 ± 0.05ab	0.78 ± 0.04b	0.82 ± 0.03ab
Deutochrysalis	0.91 ± 0.06 ab	0.97 ± 0.08 a	0.69 ± 0.05b	0.79 ± 0.05ab	0.83 ± 0.04ab	0.80 ± 0.03ab
Deutonymph	0.93 ± 0.05 a	0.84 ± 0.05 a	0.97 ± 0.07a	0.89 ± 0.05a	0.85 ± 0.05a	0.88 ± 0.05a
Theliochrysalis	0.87 ± 0.03 b	1.07 ± 0.06 a	0.76 ± 0.04b	0.86 ± 0.03b	0.89 ± 0.03b	0.83 ± 0.04b
Developmental time	9.03 ± 0.11b	9.77 ± 0.10a	8.62 ± 0.10bc	8.50 ± 0.08c	8.66 ± 0.09bc	8.89 ± 0.11bc
Male						
Egg	3.58 ± 0.14ab	4.09 ± 0.16a	4.00 ± 0.11ab	3.46 ± 0.13b	3.53 ± 0.14b	3.92 ± 0.07ab
Larva	0.87 ± 0.06a	0.86 ± 0.07a	0.72 ± 0.06a	0.86 ± 0.10a	0.80 ± 0.07a	0.69 ± 0.07a
Protochrysalis	0.88 ± 0.06a	1.00 ± 0.11a	0.97 ± 0.10a	0.85 ± 0.10a	0.69 ± 0.07a	0.96 ± 0.10a
Protonymph	0.91 ± 0.05a	0.89 ± 0.13a	0.79 ± 0.09a	0.72 ± 0.06a	1.00 ± 0.09a	0.92 ± 0.05a
Deutochrysalis	0.66 ± 0.07a	0.67 ± 0.09a	0.96 ± 0.08a	0.76 ± 0.07a	0.73 ± 0.07a	0.73 ± 0.07a
Deutonymph	1.04 ± 0.09a	0.62 ± 0.09b	0.73 ± 0.06ab	0.84 ± 0.11ab	0.86 ± 0.07ab	0.92 ± 0.05ab
Theliochrysalis	0.83 ± 0.07a	1.02 ± 0.11a	0.73 ± 0.06a	0.74 ± 0.07a	0.75 ± 0.07a	0.84 ± 0.06a
Developmental time	8.79 ± 0.24ab	9.17 ± 0.20a	8.92 ± 0.19ab	8.25 ± 0.18b	8.39 ± 0.11b	9.00 ± 0.11ab

The means followed by different letters within the same raw are significantly different ($P < 0.05$, Tukey's test).

Table 2. Survival rate, fecundity, sex ratio, adult longevity, pre-oviposition, oviposition and post-oviposition periods of *Tetranychus kanzawai* females on six bean genotypes under laboratory conditions.

	Bean genotypes					
	KS31288	**KS31292**	**KS31287**	**KS31285**	**Goli**	**Akhtar**
Survival rate%	0.78	0.78	0.77	0.85	0.79	0.80
longevity	10.10 ± 0.67a	7.42 ± 0.77b	7.41 ± 0.56b	5.44 ± 0.29b	7.50 ± 0.77b	6.02 ± 0.47b
Life span	19.17 ± 0.69a	17.17 ± 0.76ab	15.99 ± 0.54bc	13.96 ± 0.33c	16.11 ± 0.78bc	15.01 ± 0.50bc
Fecundity	71.40 ± 8.04a	34.81 ± 7.03bc	25.20 ± 4.40bc	28.88 ± 3.84bc	40.65 ± 6.42b	19.44 ± 3.26c
Daily fecundity	8.59 ± 0.52a	5.21 ± 0.54bc	4.54 ± 0.41c	6.80 ± 0.58ab	6.92 ± 0.52ab	4.94 ± 0.49bc
Sex ratio% (F/(F+M))	0.76	0.75	0.63	0.72	0.75	0.76
Pre-oviposition	1.16 ± 0.10ab	0.96 ± 0.08b	1.58 ± 0.13a	0.97 ± 0.07b	1.19 ± 0.12ab	1.29 ± 0.08ab
Oviposition	7.80 ± 0.66a	5.23 ± 0.54b	4.29 ± 0.58b	3.67 ± 0.29b	5.19 ± 0.65b	3.35 ± 0.32b
Post-oviposition	1.16 ± 0.16a	1.23 ± 0.15a	1.54 ± 0.22a	0.79 ± 0.16a	1.12 ± 0.20a	1.26 ± 0.27a

Means followed by the different letters in the same raw are significantly different ($P < 0.05$, Tukey's test).

Tetranychus kanzawai successfully reproduced on all genotypes; however, the total fecundity differed among them ($F_{5, 173} = 10.95$; $P < 0.01$). The highest and lowest values of total fecundity were found on KS31288 (71.40 eggs) and Akhtar (19.44 eggs), respectively (Table 2). Mean daily fecundity was different among tested genotypes ($F_{5, 173} = 8.30$; $P < 0.01$). The highest value was found on KS31288 (8.59 eggs/female/day) and the lowest on KS31287 (4.54 eggs/female/day). Duration of pre-oviposition ($F_{5, 173}$ = 4.39; P < 0.01) and oviposition ($F_{5, 173}$ = 9.21; P < 0.01) periods were significantly affected by bean genotypes. However, the effect of tested genotypes on post-oviposition ($F_{5, 173}$ = 1.35; P = 0.247) period was not significant (Table 2). The age-specific fecundity (m_x) of *T. kanzawai* on the tested genotypes is shown in figure 1. The maximum number of offspring produced per female on KS31287, KS31285, KS31292, Akhtar, Goli, and KS31288 was 4.75, 8.04, 4.61, 6.33, 8.41 and 10.62 (offspring /female/day) and occurred at age of 11, 12, 12, 13, 12 and 15th d, respectively.

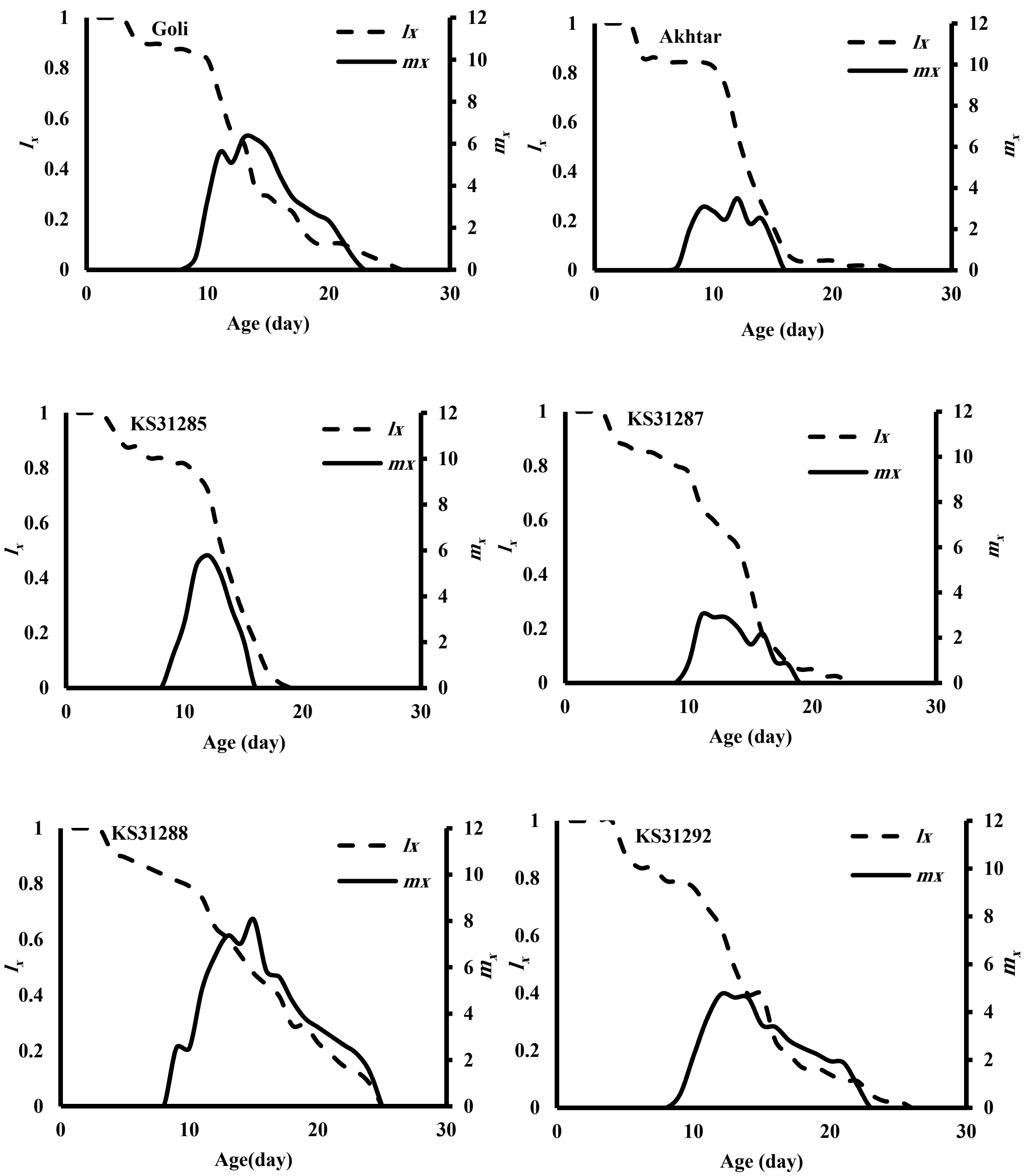

Figure 1. Age-specific survival rate (l_x) (dotted line) and age-specific fecundity (m_x) (solid line) of *Tetranychus kanzawai* female reared on six bean genotypes under laboratory conditions.

Population growth parameters

Estimated population growth parameters of *T. kanzawai* on tested bean genotypes are shown in Table 3. The net reproductive rate (R_0) ranged from 11.82 offspring on Akhtar to 43.21offspring on KS31288 ($F_{5, 173}$ = 11.33; P < 0.01). The intrinsic rate of increase (r_m) varied significantly among tested genotypes ($F_{5, 173}$ = 4.51; P < 0.001). The r_m value was highest on KS31288 and KS31285, decreased on the other genotypes in following order: Goli, Akhtar, KS31292, and KS31287. The highest and lowest r_m values were 0.303 and 0.229 day^{-1}, respectively. The finite rate of increase (λ) was lowest on KS31287 (1.258 day^{-1}) and highest on KS31288 (1.354 day^{-1}) ($F_{5, 173}$ = 4.26; P < 0.01). The mean generation time (T) ($F_{5, 173}$ = 12.45; P < 0.01) and doubling time (DT) ($F_{5, 173}$ = 5.68; P < 0.01) were significantly influenced by bean genotype (Table 3). T was longest on KS31288 (12.09 days) and shortest on Akhtar (8.54 days) and DT on KS31287 (3.00 days) was significantly longer than the other genotypes (Table 3).

Table 3. Population growth parameters (mean ± SE) of *Tetranychus kanzawai* on six bean genotypes under laboratory conditions.

Demographic parameters	Bean genotypes					
	KS31288	KS31292	KS31287	KS31285	Goli	Akhtar
***R*₀ (offspring)**	43.21 ± 5.04a	20.36 ± 4.11b	12.53 ± 2.13b	18.09 ± 2.55b	24.10 ± 3.80b	11.82 ± 1.99b
r_m (day^{-1})	0.303 ± 0.01a	0.259 ± 0.01ab	0.229 ± 0.01b	0.302 ± 0.01a	0.291 ± 0.01a	0.290 ± 0.01a
***T* (day)**	12.09 ± 0.62a	11.71 ± 0.41a	11.04 ± 0.46ab	9.58 ± 0.20bc	10.99 ± 0.33ab	8.54 ± 0.25c
***DT* (day)**	2.27 ± 0.07b	2.66 ± 0.13ab	3.00 ± 0.1a	2.28 ± 0.09b	2.38 ± 0.08b	2.41 ± 0.12b
λ (day^{-1})	1.354 ± 0.01a	1.295 ± 0.01ab	1.258 ± 0.01b	1.353 ± 0.01a	1.338 ± 0.01a	1.337 ± 0.02a

Means followed by different letters within the same row are significantly different (P <0.05, Tukey's test).

DISCUSSION

It is well known that the quality of host plants affects the growth, survival, and reproduction of phytophagous arthropods such as spider mites. To assess the amount of this effect on phytophagous arthropod characters, the life table parameters are reliable tools. Life table parameters provide population growth rates of an insect in the current and next generations (Frel *et al*. 2003) and therefore understanding them is essential to develop an integrated pest management strategy (Sedaratian *et al*. 2011). Host plant resistance has main effects on development, mortality, and fecundity of insects and mites (Modarres Najafabadi *et al*. 2014). According to previous reports, the common bean plant has anti feeding compounds such as phytic acid, lectins, saponin and trypsin inhibitors that have negative effect on the biological parameters of phytophagous pests and the amount of these compounds are different in various bean varieties (Roozbahani *et al*. 2016; Rui *et al*. 2016). Also, other researchers reported other secondary metabolites such as alpha amylase (Suzuki *et al*. 1993) or flavonoids in resistant plants as resistance factors in different genotypes of bean (Lima *et al*. 2014). Our study declares that developmental time, fecundity and survival rate of *T. kanzawai* were influenced by tested bean genotypes. Total developmental times of females significantly differed among six bean genotypes and varied from 8.50 days on KS31285 to 9.77 days on KS31292. Similar to our findings, 7.40 to 8.77 days were reported as total immature stage periods of *T. kanzawai* on six soybean genotypes (Shamsedin Beyranvand 2017). Also, the total immature stage of *T. kanzawai* females on bean was reported as 8.2 days at 27.5 ºC by Ullah *et al*. (2011). The developmental time of *Tetranychus merganser* Boudreaux was 8.8 days on bean at 27.5 ºC (Ullah *et al*. 2011). Also, other researchers reported that the immature development time of spider mites differs on various host plants

(Razmjou *et al*. 2009; Sedaratian *et al*. 2011; Modarres Najafabadi *et al*. 2014). The developmental time for *T. urticae* on five Chiti bean cultivars were reported from 15.89 days to 19.37 days at 27 °C (Modarres Najafabadi 2012).

In the present study, the adult longevity of female varied from 5.44 days on KS31285 to 10.10 days on KS31288 which are lower than those reported by other researchers. This time was reported to be from 14.02 days to 22.03 days on six soybean genotypes for *T. kanzawai* (Shamsedin Beyranvand 2017). In another study, 23.2 days at 25 ºC and 10.2 days at 30 ºC were reported for this mite by Ullah *et al*. (2011). The adult longevity of *T. bastosi* reared on bean was reported as 16.9 days (De Lima *et al*. 2017). The immature survival rate in our study ranged from 77 to 85% on bean genotypes. Ullah *et al*. (2011) found 84.2% immature survival rate for *T. kanzawai* reared on bean at 27.5 ºC, which is close to our findings.

Total fecundity of *T. kanzawai* in current study ranged from 19.44 to 71.40 eggs which obviously are lower than those reported for this mite. Ullah *et al*. (2011) found 198.5 and 93.3 eggs for *T. kanzawai* on bean at 25 and 30 ºC, respectively. Total fecundity for *T. urticae* on five Chiti bean cultivars was reported from 82.45 to 142.05 eggs (Modarres Najafabadi 2012). Razmjou *et al*. (2009) reported that *T. urticae* on bean, cowpea, and soybean produced 34.50, 65.53 and 83.16 eggs at 25 ºC. The total fecundity of *T. bastosi* reared on bean was reported as 36.1 eggs (De Lima *et al*. 2017).

The life table parameters, particularly, the intrinsic rate of natural increase (r_m), are the most important parameters to be used to assess plant resistance levels to insects (Razmjou *et al*. 2006). The r_m values in our research were ranged from 0.229 to 0.303 day^{-1} that is lower than those reported for this mite. Ullah *et al*. (2011) reported 0.282 and 0.399 day^{-1} as r_m of *T. kanzawai* reared on bean at 25 and 30 ºC, respectively. These findings show that tested red bean genotypes in our study are relatively resistant to *T. kanzawai*. Ahmadi *et al*. (2007) reported the r_m for *T. urticae* on four bean varieties (Talash, Sadaf, Goli, and Parastoo) as 0.142, 0.079, 0.095 and 0.038 day^{-1}. Finally, our study shows that among tested bean genotypes, KS31288 and KS31287 were partially susceptible and resistant to *T. kanzawai*, respectively. However, it is suggested to perform field studies to evaluate the resistance of these genotypes in field conditions and then genotypes such as KS31287 and KS31292 that restricted the development of *T. kanzawai*, to be used in IPM program to control this mite.

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پارامترهای جدول زندگی کنهٔ *Tetranychus kanzawai* Kishida (Acari: Tetranychidae) روی شش ژنوتیپ لوبیا قرمز

صبا سپهوندیان[۱]، شهریارجعفری[۱*]، امیر محسنی امین[۲] و جهانشیر شاکرمی[۱]

۱. گروه گیاهپزشکی، دانشکده کشاورزی، دانشگاه لرستان، ایران؛ رایانامه‌ها: saba.sepahvandian@gmail.com، Shahriar.jafari@gmail.com و Jafari.s@lu.ac.ir، shakarami.j@lu.ac.ir

۲. مرکز تحقیقات و آموزش کشاورزی و منابع طبیعی لرستان، پردیس بروجرد، ایران؛ رایانامه: a.mohseni@areeo.ac.ir

* نویسندهٔ مسئول

چکیده

کنهٔ تارتن *Tetranychus kanzawai* Kishida (Acari: Tetranychidae) یکی از آفات مهم محصولات گوناگون است که خسارت آن در سال‌های اخیر در برخی مناطق ایران افزایش یافته است. پارامترهای جدول زندگی این کنه روی شش رقم لوبیا قرمز شامل KS31288، KS31287، KS31292، KS31285، Akhtar و Goli در دمای ۱±۲۸ درجهٔ سلسیوس، رطوبت نسبی ۱۰±۵۰ درصد و دوره نوری ۱۶ ساعت روشنایی و ۸ ساعت تاریکی مطالعه شد. طول دوره رشد و نمو این کنه تحت تأثیر ژنوتیپ‌ها قرار گرفت و از ۸/۵۰ روز روی KS31285 تا ۹/۷۷ روز روی KS31292 متفاوت بود. بیش‌ترین و کم‌ترین درصد نرخ زنده‌مانی مراحل نابالغ به میزان ۰/۸۵ روی KS31285 و ۰/۷۷ روی KS31287 مشاهده شد. میزان زادآوری نیز تحت تأثیر ژنوتیپ‌های مورد مطالعه قرار گرفت و دارای بیش‌ترین میزان روی KS31288 (۷۱/۴۰ تخم) و کم‌ترین میزان روی Akhtar (۱۹/۴۴ تخم) بود. میزان متوسط هر نسل (*T*) دارای کوتاه‌ترین مقدار روی Akhtar (۸/۵۴ روز) و بلندترین مقدار روی KS31288 (۱۲/۰۹ روز) بود. کم‌ترین میزان نرخ ذاتی افزایش جمعیت روی KS31287 و بیش‌ترین میزان آن روی KS31285 و KS31288 به‌دست آمد. بر اساس نتایج به‌دست آمده KS31288 و KS31287 به ترتیب حساس‌ترین و مقاوم‌ترین ژنوتیپ‌های لوبیا بودند. نتایج این پژوهش اطلاعات مفیدی در مورد طراحی یک برنامه مدیریت تلفیقی برای کنترل این آفت ارایه می‌کند.

واژگان کلیدی: مقاومت آنتی بیوزی؛ ژنوتیپ‌های لوبیا؛ ماده؛ کنهٔ تارتن کانزاوا؛ چرخهٔ زندگی.

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