

## Article

### The effect of common bean cultivars on life table parameters of *Tetranychus urticae* (Acari: Tetranychidae)

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#### Abstract

It is well recognized that the quality of host plants affects the development and survival of herbivorous arthropods. The life table parameters of *Tetranychus urticae* Koch, on six cultivars of common bean (*Phaseolus vulgaris* L.) "chiti Khomein, chiti Ks21189, red Akhtar, red Ks31169, white Pak and white G11867" were studied at constant laboratory conditions (27±2°C, 70±5% RH and 16 L:8 D h), during 2009–2011. Results showed that the immature developmental times of males and females were significantly influenced by bean cultivars. *Tetranychus urticae* laid significantly more eggs per day on red Akhtar cultivar (16.16) compared with the other cultivars. The mean generation time affected by different cultivars and it's ranged varied from 23.37 to 34.82 days. Percentage the egg hatching of TSSM ranged varied from 88.25% to 94.20%. The highest intrinsic rate of increase ( $r_m$ ), was recorded on red Akhtar (0.269±0.031day<sup>-1</sup>) and the lowest value was obtained on white Pak (0.129±0.048day<sup>-1</sup>). In addition, net reproductive rate ( $R_0$ ) and finite rate of increase ( $\lambda$ ) of the TSSM had the highest value on red Akhtar (62.38±1.05 female offspring and 1.30±1.02 day<sup>-1</sup>, respectively). The lowest values of these parameters were recorded on white Pak as 27.37±1.40 female offspring and 1.13±1.10 day<sup>-1</sup>, respectively. Doubling time ( $DT$ ) varied significantly on different cultivars and its shortest and longest values were obtained on red Akhtar and white Pak, respectively. Our findings revealed that white beans (Pak and G11867) were less suitable cultivars, suggesting that they are more resistant to the TSSM than the other cultivars.

**Keywords:** Two-spotted spider mite, Development, Life table, Common bean cultivars

#### Introduction

Common bean (*Phaseolus vulgaris* L.) is one of the most important and widely cultivated crops in the world (Tsagkarakou *et al.* 2002), and commercially planted in Markazi, Lorestan, Fars and Zanjan provinces of Iran. Based on reports by the Iranian Ministry of Agriculture (Statistical Bulletin, Iran 2005) this crop is grown on more than 105,000 ha annually in Iran. Various pests affect common bean production in Iran, among which the two-spotted spider mite (TSSM), *Tetranychus urticae* Koch, is

considered important in many bean-growing areas of Iran (Khanjani 2005; Khanjani & Haddad 2006). The rapid developmental rate, short generation time and high net reproductive rate of *T. urticae* allows them to achieve damaging population levels very quickly when growth conditions are good, resulting in an equally rapid decline of host plant quality (Fathipour *et al.* 2006; Razmjou *et al.* 2009c). The population growth parameters of *T. urticae* such as developmental rate, survival, reproduction and longevity may vary in response to changes in temperature, host plant species, host plant nutrition, cultivar kind, phenological stage of host plants, exposure to pesticides, relative humidity (Skorupska 2004; Khodayari *et al.* 2008).

Life and fertility tables are powerful tools for analyzing and understanding the impact that an external factor has upon the growth, survival, reproduction and rate of increase of an insect population (van den Boom *et al.* 2003; Musa & Ren 2005; Greco *et al.* 2006). The quality of host plants has main effects on development, mortality and fecundity rates of insects and mites (Fu *et al.* 2002; Greco *et al.* 2006).

Population growth parameters, including net reproductive rate ( $R_0$ ), mean generation time ( $T$ ), doubling time ( $DT$ ), finite rate of increase ( $\lambda$ ) and intrinsic rate of natural increase ( $r_m$ ) have been used to evaluate the susceptibility or resistance of several host plants in relation to various pests (Satar & Yokomi 2002; Razmjou *et al.* 2009a; Sedaratian *et al.* 2011). Among these parameters, the intrinsic rate of increase is commonly used to evaluate the level of plant resistance to insects (Razmjou *et al.* 2006; Sedaratian *et al.* 2009). Therefore, Knowledge of cultivar susceptibility or resistance might be a fundamental component of an integrated pest management program (IPM) for any crop. Such information can be used in developing an insect-resistant cultivar (Jyoti *et al.* 2001; Yang & Chi 2006) or designing and good assays for breeding new varieties (Stoner & Shelton 1988).

Despite its economic importance and worldwide distribution, relatively little is known about the population growth parameters of TSSM on different common bean cultivars. Hence, the goal of this study was to evaluate the population growth characteristics of TSSM on six bean cultivars in Iran.

## Materials and methods

### *Mite colony*

For providing the stock cultures of *T. urticae* the individuals of TSSM were originally collected from common bean fields of the Khomein region, Iran during May 2009. These mites were reared on Black eye pea (*Vigna sinensis* L.) grown in plastic pots (20 cm diameter, 25cm height) in a growth chamber ( $27\pm 2^\circ\text{C}$ ,  $70\pm 5\%$  RH and a photoperiod of 16L:8D h) for at least two months (several generations) before conducting the experiments. All experiments were performed at the above-mentioned conditions in growth chambers. This study was conducted in laboratory of the Department of Entomology, Islamic Azad University, Arak Branch, Iran during 2009–2011.

### *Plant materials*

In this study six bean cultivars including chiti beans "Khomein and Ks21189", red beans "Akhtar and Ks31169" and white beans "Pak and G11867" were used. The cultivars were obtained from the Bean Research Institute of Khomein, Iran. The seeds of beans were sown in plastic pots (20 cm diameter, 25 cm height) filled with fertilized field soil. Each cultivar was planted in 20 replications and maintained in a greenhouse.

After four weeks, bean leaves were detached and used for leaf disc arena. During the experiments, all plants were irrigated at the same time and no fertilizers or pesticides were used. For prevent the infestation of the planted bean by different pests, all cultivars were planted in greenhouse under controlled conditions.

#### *Leaf discs*

To perform the experiments, the leaf disc method was used (Pedigo & Buntin 1994; Naher *et al.* 2006). Each leaf disc was 4 cm<sup>2</sup> of area which cut from the center of leaves. Each leaf disc was placed on the center of plastic Petri dishes (8 cm diameter, 1.5 cm height). Afterwards, a fully expanded young leaf (third leaf below the apical meristem of one-month-old plants) was used for the leaf disc preparation. The leaves of different common bean cultivars were selected from all replications and cut into a leaf disc (2 × 2cm) and then placed upside down on water-saturated cotton in the Petri dish. During the experiments, all the common bean cultivars were periodically planted in the greenhouse (every 10 days), and to reduce the effects of plant age on mite development and fecundity, the new leaf discs were prepared from their plants and the mites transferred on them.

#### *Experiments*

The life table parameters of *T. urticae* were determined on six bean cultivars in laboratory conditions at 27±2°C, 70±5% humidity and a photoperiod of 16 L: 8 D h. The study was initiated with 120 cohort eggs of the TSSM for each cultivar. In this regards, 10 pairs of TSSM (reared on each cultivar), were transferred onto the new leaf discs of the same cultivar. Twelve hours later, the laid eggs were collected from these leaf discs and individually transferred with a fine camel hair brush onto new leaf discs. An individual egg laid was placed on a leaf disc in a Petri dish and reared through all stages to adulthood. All the transferred eggs and subsequent stages (larva, nymph and adult) were carefully checked daily until reaching adulthood and their survival and molting to the next stage were recorded. As soon as adults emerged, the females were differentiated by their round caudal ends against males with pointed caudal ends. From these data we calculated the hatchability of mite eggs, the immature survivorship and the sex ratio. This assay was performed in 120 replicates for life table and 20 replicates for fertility tables for each cultivar.

To estimate the mite fecundity, one newly emerged female from the development experiment and one male collected from the stock culture (for mating) were introduced into a Petri dish with a fresh leaf disc on water-saturated cotton. When females began to lay eggs, their eggs were counted and removed daily until all experimental females died. The ovipositing females were transferred to the new leaf discs every three days. In this way, we evaluated the fecundity of 20 two-spotted mite females per each bean cultivar.

#### *Data analysis*

The age-specific fecundity ( $m_x$ ) and age-specific survival ( $l_x$ ) of females on six bean cultivars were calculated according Birch (1948) and the population growth parameters including net reproductive rate ( $R_0$ ), intrinsic rate of natural increase ( $r_m$ ), finite rate of increase ( $\lambda$ ), mean generation time ( $T$ ) and doubling time ( $DT$ ) estimated based on suggested formula by Carey (1993).

Data on immature developmental period and adult longevity of TSSM were analyzed with one-way analyses of variance (ANOVA). When the variation among

cultivars was significant, means comparisons were done based on Duncan's multiple range test ( $P < 0.05$ ). Tests of significance for population level life table parameters among the bean cultivars were conducted using the jackknife procedure (Meyer *et al.* 1986; Maia *et al.* 2000). In this procedure, jackknife pseudo values of each life table parameter were calculated for  $n$  females by following equation:

$$A_{(j)} = n \times A_{(all)} - (n - 1) \times A_{(i)}$$

Where  $A_{(j)}$  is the jackknife pseudo value,  $n$  is the number of females,  $A_{(all)}$  is the calculated life table parameters for all females and  $A_{(i)}$  is the calculated parameters for  $(n-1)$  females. Various life table parameters including:  $r_m$ ,  $R_0$ ,  $T$ ,  $\lambda$  and  $DT$  were inserted in this equation instead of  $(A)$ . Subsequently,  $n$  calculated jackknife pseudo values were subjected to one-way ANOVA and if significant differences were detected, a Duncan's multiple range test was run ( $P < 0.05$ ). The obtained sex ratios of offspring were compared to expected ratio of 1:1 by a chi-square test ( $\chi^2$ ,  $P < 0.05$ ). A  $t$ -test was run for comparison of total immature developmental times of males and females on the same cultivar. All statistical analyses were carried out using the Minitab statistical software (MINITAB 2000) and SPSS statistical packages (SPSS 2004).

## Results

### *Developmental times of immature stages*

The developmental times of various stages (males and females) of TSSM on six bean cultivars are given in Table 1. Egg incubation period did not differ among the six cultivars ( $F = 3.21$ ;  $df = 5, 714$ ;  $P > 0.05$ ). The developmental periods of larvae ( $F = 8.56$ ;  $df = 5, 648$ ;  $P < 0.05$ ), protonymphs ( $F = 3.71$ ;  $df = 5, 600$ ;  $P < 0.05$ ) and deutonymphs ( $F = 6.89$ ;  $df = 5, 566$ ;  $P < 0.05$ ) showed significant differences among various host plants.

Total immature developmental time for males ( $F = 6.89$ ;  $df = 5, 96$ ;  $P < 0.05$ ) and females ( $F = 9.63$ ;  $df = 5, 428$ ;  $P < 0.05$ ) was significantly different among the six cultivars and its range varied from  $12.00 \pm 0.17$  to  $24.74 \pm 0.24$  days for females and from  $12.19 \pm 0.25$  to  $23.34 \pm 0.31$  days for males on red Akhtar and white Pak, respectively (Table 1). Among cultivars, development times of males and females did not differ ( $t$ -test,  $\alpha = 0.05$ ).

### *Hatchability, Sex ratio & immature mortality*

The life span, egg hatchability, immature stages mortality and sex ratio of *T. urticae* on six bean cultivars are shown in Table 2. The life span (male and female), differed significantly among cultivars (males:  $F = 9.52$ ;  $df = 5, 96$ ;  $P < 0.05$ ; females:  $F = 13.36$ ;  $df = 5, 428$ ;  $P < 0.05$ ). The longest and shortest value of life span period was recorded on white Pak and red Akhtar cultivar, respectively. The life span of females was significantly longer than the males. Egg hatchability ranged varied from 88.25% to 94.20%. Immature stages mortality rate varied from 11.65 to 18.75% on different bean cultivars. The greatest mortality during immature stages occurred on white Pak and the lowest occurred on red Akhtar. Among immature stages, the greatest mortality occurred during the egg stage. The sex ratio (male: female) of offspring on all bean cultivars were significantly female-biased. The greatest (1:4.71) and lowest (1:3.81) sex ratios observed on red Akhtar and white Pak cultivars, respectively (Table 2).

### *Female longevity and fecundity*

The pre-oviposition, oviposition, post-oviposition periods and females longevity of TSSM on six bean cultivars are shown in Table 3.

**Table 1.** Developmental times (in days) of immature stages of *Tetranychus urticae* on six bean cultivars in laboratory conditions (Mean± SE).

| Stages | Bean cultivars |               |              |              |              |              |
|--------|----------------|---------------|--------------|--------------|--------------|--------------|
|        | Chiti Khomein  | Chiti Ks21189 | Red Akhtar   | Red Ks31169  | White Pak    | White G11867 |
| E      | 2.00±0.04 a    | 2.15±0.04 a   | 2.00±0.03 a  | 2.00±0.03 a  | 2.00±0.03 a  | 2.23±0.04 a  |
|        | 2.01±0.09 b    | 2.63±0.08 a   | 2.00±0.09 b  | 2.00±0.07 b  | 2.41±0.12 a  | 2.17±0.09 b  |
| L      | 5.21±0.06 c    | 5.63±0.02 c   | 3.39±0.06 d  | 6.21±0.02 b  | 7.96±0.11 a  | 7.58±0.04 a  |
|        | 4.45±0.04 bc   | 5.56±0.05 b   | 3.28±0.03 c  | 6.32±0.08 ab | 7.21±0.09 a  | 6.96±0.05 ab |
| P      | 4.35±0.02 b    | 5.45±0.08 ab  | 3.25±0.05 c  | 5.86±0.06 ab | 6.86±0.06 a  | 5.95±0.03 ab |
|        | 4.45±0.06 b    | 5.26±0.05 ab  | 3.32±0.09 c  | 5.75±0.02 ab | 6.62±0.08 a  | 5.92±0.07 ab |
| D      | 4.40±0.08 bc   | 5.21±0.09 b   | 3.36±0.03 c  | 6.58±0.05 ab | 7.92±0.04 a  | 6.98±0.06 ab |
|        | 4.98±0.05 bc   | 5.43±0.06 b   | 3.59±0.04 c  | 6.42±0.03 ab | 7.10±0.02 a  | 6.89±0.10 ab |
| T      | 15.96±0.20 e   | 18.44±0.23 d  | 12.00±0.17 f | 20.65±0.16 c | 24.74±0.24 a | 22.74±0.17 b |
|        | 15.89±0.24 d   | 18.88±0.24 c  | 12.19±0.25 e | 20.49±0.20 b | 23.34±0.31a  | 21.94±0.31 b |

E: egg; L: larva and quiescent stage; P: protonymph and quiescent stage; D: deutonymph and quiescent stage; T: total developmental time.

Means followed by similar letters in each rows are not significantly different (One-Way ANOVA,  $\alpha=0.05$ ).

The oviposition periods ( $F= 8.35$ ;  $df= 5,428$ ;  $P< 0.05$ ) and post-oviposition periods ( $F= 6.14$ ;  $df= 5,428$ ;  $P< 0.05$ ) of TSSM are significantly influenced by the bean cultivars. No significant host plant effects were observed on the pre-oviposition period of TSSM ( $F= 5.24$ ;  $df= 5,398$ ;  $P> 0.05$ ). Host plant cultivars significantly affected on the females longevities ( $F= 11.58$ ;  $df= 5,428$ ;  $P< 0.05$ ). The shortest and longest female's longevities were observed on white Pak and red Akhtar, respectively.

**Table 2.** Life span (Mean± SE), egg hatchability, immature mortality and sex ratio of *Tetranychus urticae* on six bean cultivars in laboratory conditions.

| Bean cultivars | Life span (day) |               | Egg hatchability (%) | Immature mortality (%) | Sex ratio (♂:♀) |
|----------------|-----------------|---------------|----------------------|------------------------|-----------------|
|                | ♀               | ♂             |                      |                        |                 |
| Chiti Khomein  | 27.07±1.70 b    | 21.36±1.25 b  | 93.40                | 12.35                  | 1:4.62*         |
| Chiti Ks21189  | 29.39±1.91 ab   | 23.99±1.14 ab | 91.05                | 15.77                  | 1:4.31*         |
| Red Akhtar     | 23.37±1.08 b    | 17.94±1.21 b  | 94.20                | 11.65                  | 1:4.71*         |
| Red Ks31169    | 31.51±2.05 ab   | 24.81±2.25 ab | 89.25                | 14.02                  | 1:4.09*         |
| White Pak      | 34.82±2.62 a    | 26.56±2.87 a  | 88.25                | 18.75                  | 1:3.81*         |
| White G11867   | 32.88±2.32 a    | 25.91±2.56 a  | 90.50                | 16.55                  | 1:4.00*         |

Means followed by similar letters in column are not significantly different (one-way ANOVA,  $\alpha=0.05$ ).

\* Significant difference with expected ratio of 1:1 ( $X^2$ ,  $P<0.05$ ).

Mean daily per capita egg production ( $F= 8.21$ ;  $df= 5,54$ ;  $P< 0.05$ ) and total fecundity ( $F= 14.56$ ;  $df= 5,54$ ;  $P< 0.05$ ) of TSSM differed significantly among cultivars (Table 3). Daily egg production was highest on red Akhtar, which was significantly greater than the other cultivars. Total fecundity of TSSM has highest value on red Akhtar.

Age-specific survival ( $l_x$ ) and age-specific fecundity ( $m_x$ ) of *Tetranychus urticae* on six bean cultivars presented in fig. 1. The results of present study indicate that TSSM completed its development on all bean cultivars. The highest and lowest survival rates of immature stages were recorded on red Akhtar and white Pak, respectively (Fig. 1).

**Table 3.** Reproduction parameters and adult longevity of *Tetranychus urticae* on six bean cultivars in laboratory conditions (Mean± SE).

|                   | Bean cultivars |               |               |               |               |               |
|-------------------|----------------|---------------|---------------|---------------|---------------|---------------|
|                   | Chiti Khomein  | Chiti Ks21189 | Red Akhtar    | Red Ks31169   | White Pak     | White G11867  |
| Stages            |                |               |               |               |               |               |
| Pre-oviposition   | 1.28±0.04 a    | 1.37±0.07 ab  | 1.00±0.04 a   | 1.50±0.08 ab  | 2.10±0.23 b   | 1.93±0.16 b   |
| Oviposition       | 8.63±0.95 a    | 8.58±1.02 a   | 8.95±0.80 a   | 8.36±1.10 a   | 6.98±1.22 b   | 7.25±1.19 ab  |
| Post-oviposition  | 1.20±0.51 a    | 1.00±0.59 a   | 1.40±0.40 a   | 1.00±0.71 a   | 1.00±0.93 a   | 1.00±0.80 a   |
| Adult longevity   | 11.11±1.50 b   | 10.95±1.68 ab | 11.35±1.24 b  | 10.86±1.89 ab | 10.08±2.38 a  | 10.18±2.15 a  |
| Reproduction rate |                |               |               |               |               |               |
| Daily Fecundity   | 13.33±1.47 b   | 12.09±1.69 bc | 16.16±1.25 a  | 10.98±1.89 c  | 12.63±2.12 bc | 12.39±1.98 bc |
| Total Fecundity   | 116.54±6.98 b  | 99.55±8.23 bc | 142.05±6.58 a | 90.52±8.54 c  | 82.45±8.89 c  | 89.05±8.21 c  |

Means followed by similar letters in each rows are not significantly different (one-way ANOVA,  $\alpha=0.05$ ).

### Population growth parameters

Population growth parameters of the TSSM on the six bean cultivars are presented in Table 4. There were significant differences among cultivars for all population growth parameters ( $R_0$ ,  $r_m$ ,  $\lambda$ ,  $T$  and  $DT$ ). The net reproductive rate ( $R_0$ ) was the highest on red Akhtar and lowest on white Pak. The intrinsic rate of natural increase ( $r_m$ ) and the finite rate of increase ( $\lambda$ ) showed a pattern similar to  $R_0$  in which it was highest on red Akhtar and lowest on white Pak cultivars. The mean generation time ( $T$ ), is required time for population of TSSM to multiply as  $R_0$  and varied from 15.24±1.12 to 25.55±1.04 days on red Akhtar and white Pak cultivars, respectively. The lowest and greatest values of doubling times ( $DT$ ) were estimated to be 2.54±1.14 and 5.33±1.25 days on red Akhtar and white Pak cultivars, respectively.

### Discussion

In the present study, biological characteristics of TSSM were investigated on six bean cultivars. These parameters indicate the insect population growth rates in the current and next generations (Frel *et al.* 2003) and understanding them is essential to develop an integrated pest management (IPM) strategy (Wilson & Huffaker 1976; Naseri *et al.* 2011).

In this research, the results showed that the development times of TSSM differed among bean cultivars. In other words, the population growth parameters of *T. urticae* are varying in response to changes in bean cultivars. The required time for immature development of *T. urticae* on different bean cultivars was significantly varied in our results that confirmed with obtained results by Mondal & Ara (2006) on fresh bean (*Lablab purpureus* L.), Deciyanto *et al.* (1989) on six cultivars of *Mentha piperita* L. and *M. arvensis* L., Sedaratian *et al.* (2011) on 14 soybean genotypes and Khanamani *et al.* (2012) on seven eggplant cultivars. The profound effect of different bean cultivars on fecundity, population growth parameters, survivorship and population density of the TSSM has also been proved (Ahmadi *et al.* 2005; Fathipour *et al.* 2006; Ahmadi *et al.* 2007).

**Table 4.** Population growth parameters of *T. urticae* reared on six bean cultivars in laboratory conditions (Mean± SE).

| Parameters                        | Bean Cultivars   |                  |               |                |               |                 |
|-----------------------------------|------------------|------------------|---------------|----------------|---------------|-----------------|
|                                   | Chiti<br>Khomein | Chiti<br>Ks21189 | Red Akhtar    | Red<br>Ks31169 | White<br>Pak  | White<br>G11867 |
| $R_0$<br>(female<br>offspring)    | 60.39±1.48 a     | 51.84±1.55 b     | 62.38±1.65 a  | 38.51±1.36 c   | 26.11±1.40 d  | 27.37±1.39 d    |
| $r_m$<br>(day <sup>-1</sup> )     | 0.203±0.063 b    | 0.187±0.055 b    | 0.269±0.031 a | 0.152±0.024 c  | 0.129±0.048 d | 0.137±0.069 cd  |
| $\lambda$<br>(day <sup>-1</sup> ) | 1.22±1.01 b      | 1.20±1.08 b      | 1.30±1.02 a   | 1.16±1.01 c    | 1.13±1.10 d   | 1.14±1.12 d     |
| $T$<br>(day)                      | 20.19±1.18 c     | 21.09±1.10 c     | 15.24±1.12 d  | 24.04±1.21 b   | 25.55±1.09 a  | 23.68±1.19 b    |
| $DT$<br>(day)                     | 3.40±1.22 e      | 3.70±1.20 d      | 2.54±1.14 f   | 4.54±1.18 c    | 5.33±1.25 a   | 5.02±1.23 b     |

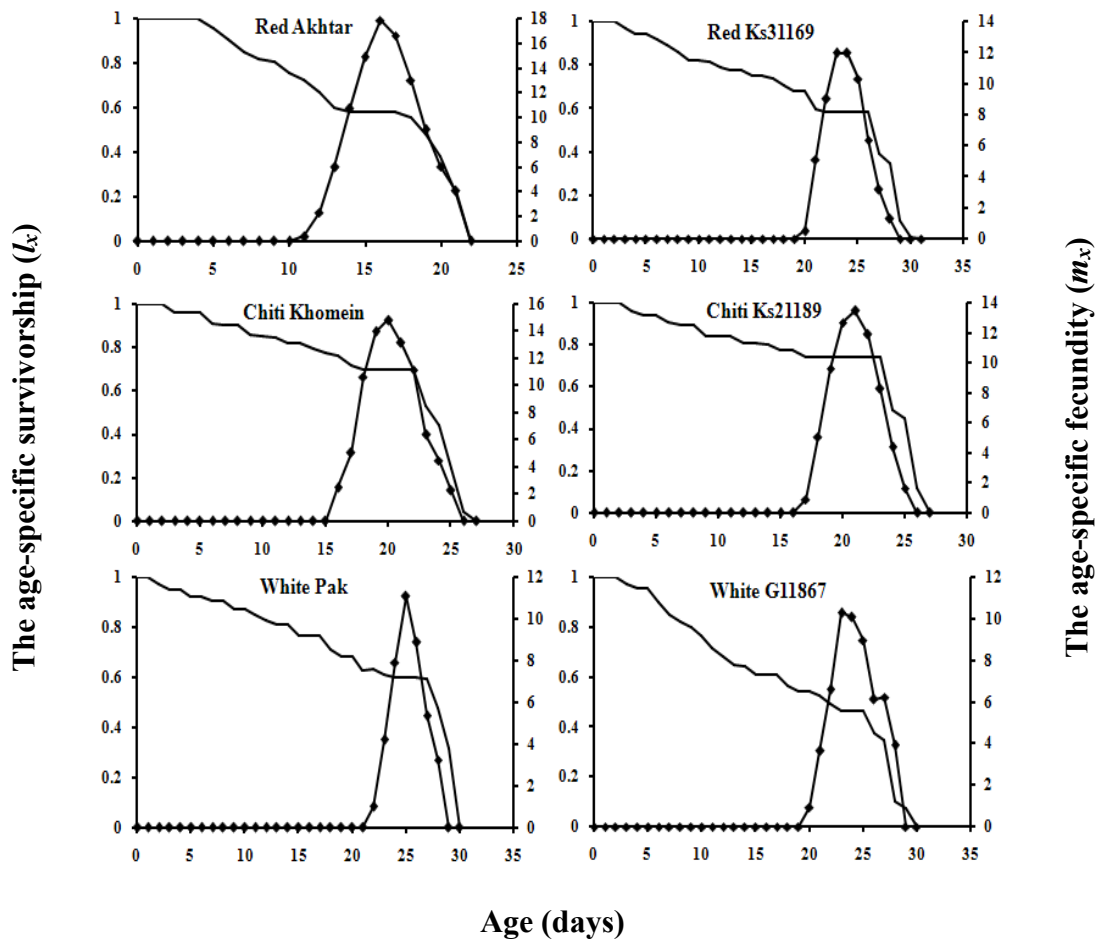
Means followed by similar letters in each rows are not significantly different (one-way ANOVA,  $\alpha=0.05$ ).

Puttaswamy (1980) on cucurbit, Adango *et al.* (2006) on *Amaranthus cruentus* L. and *Solanum macrocarpon* L., Moros & Aponte (1994) on *P. vulgaris* and da Silva (2002) on cotton, recorded developmental time of immature stages of the two spotted spider mite, that were shorter than the our findings on bean cultivars. These variations could be ascribed to differences in host plant quality, environmental factors, either reflected in differences in nutrients required by the mite or differences in the levels of secondary metabolites (Fu *et al.* 2002; Greco *et al.* 2006; Fathipour *et al.* 2006; Sedaratian *et al.* 2009, 2011). Previous studies on TSSM attributed population growth variation to be related to plant nutrition, leaf age, leaf surface structure and secondary compounds (Krips *et al.* 1998; Agrawal 2000; Balkema-Boomstra *et al.* 2003; Pietrosiuk *et al.* 2003; Skorupska 2004). Spider mite populations grew at a relatively fast and slow rate on small and large plants, respectively (Rotem & Agrawal 2003). Changes in plant quality following herbivory contribute to spider mite reproduction and survival and may explain the differential growth of spider mite populations on small and large plants (Karban 1987). Indeed, differential plant induction based on size and phenology has been previously reported (Stout *et al.* 1996).

Our findings indicated that the development times of immature stages of TSSM females were similar to males on each bean cultivar in laboratory conditions. This result is close to the results of Laing (1969), who found similar development times for males and females (16.1 and 16.9 days, respectively). The results of some researchers (Rajakumar *et al.* 2005) are different from what was reported here. Ahmadi *et al.* (2007) emphasized the occurrence of the differences between developmental rate of males and females. Shih *et al.* (1976) reported lower values for longevity of females (19.1) than males (14.6) The increase in the longevity of females may be an important adaptation for the pest to maintain its generation when food quality is low, because only a limited number of females are able to remain (Uckan & Ergin 2002; Kasap 2004; Sedaratian *et al.* 2009, 2011).

According to this study, the survival rate of immature stages of *T. urticae* was upside on the different bean cultivars (Table 1). Low mortality of immature stages suggests that the bean cultivars were not harmful to this mite. So, these results confirm Shih & Wang (1996) finding, except the development times of deutonymphs, they also demonstrated that these variations could be ascribed to differences in host plant quality

and could be affected on fecundity and longevity of development times of mite immature stages.



**Figure 1.** Age-specific survival ( $l_x$ : simple line) and age-specific fecundity ( $m_x$ : solid diamonds) of *Tetranychus urticae* on six bean cultivars.

Egg hatchability, development time and survival to adult stage were similar among bean cultivars. Razmjou *et al.* (2009b) reported total immature stages of *T. urticae* on three legumes including soybean, cowpea and bean were 9.23, 9.38 and 9.12 days, respectively that were shorter than our results. Chahine & Michellakis (1994) pointed out that no difference was found in longevity when eggplant, tomato and bean were used as hosts, but fecundity was indeed affected by the host plants. These results indicated that the developmental cycle of *T. urticae* is influenced by differences in host plant quality.

The net reproductive rate ( $R_0$ ) and the intrinsic rate of natural increase ( $r_m$ ) are important indicators of tetranychid population dynamics (Sabelis 1985; Krips *et al.* 1998). Comparisons of  $R_0$  and  $r_m$  often provide considerable insight beyond that available from the independent analysis of individual life-history parameters (Zhang *et al.* 2007). In the present study, bean cultivars greatly affected on fecundity and life-table parameters of TSSM (Table 4). The  $r_m$  values ranged from  $0.269 \pm 0.031$  to  $0.129 \pm 0.048$  day<sup>-1</sup>. The intrinsic rate of increase ( $r_m$ ) of two-spotted spider mite was the shortest on red Akhtar. This was mainly due to short development time, an early peak in

reproduction, high daily egg production and high total fecundity. Our findings revealed that White bean cultivars (Pak and G11867) were less suitable cultivars for two-spotted spider mite. Razmjou *et al.* (2009c) reported that Sayyad cultivar was the most favorable host ( $r_m = 0.295$ ) and Talash cultivar was unfavorable host ( $r_m = 0.214$ ) for two-spotted spider mite. Sabelis (1985, 1991) has reported  $r_m$  values of *T. urticae* from 0.219 to 0.336 and Ahmadi *et al.* (2007) has estimated  $r_m$  values from 0.038 to 0.142 day<sup>-1</sup> on common bean.

The estimated net reproductive rate ( $R_0$ ) on bean cultivars in present study are similar to those reported by Silva *et al.* (1985) for *T. urticae* on cotton. Ahmadi *et al.* (2007) has reported  $R_0$  values of *T. urticae* from 2.043 to 8.822 (females/female/generation) that were shorter than those reported in this study. The same situation may have influenced the mean generation time ( $T$ ), where Silva *et al.* (1985) found values between 22.2 and 24.9 days on cotton and beans, respectively, which was similar to values of this study. The higher values of  $r_m$  and  $R_0$  indicated that the susceptibility of a bean cultivar to TSSM, while the lower ones indicate that the bean cultivar is resistant to TSSM. Therefore, among examined cultivars, red Akhtar and white Pak are the most susceptible and resistant cultivars for TSSM, respectively.

Daily fecundity of TSSM, was estimated from 10.98±1.89 to 16.16±1.25 eggs/female/day and total fecundity was varied between 142.05±6.58 and 82.45±8.89 eggs/female. These parameters on cucumber (*Cucumis sativus* L.) have been reported as 5.98 and 104.85, respectively (Ullah *et al.* 2006). The total number of eggs laid per female in her lifetime was averaged as 108.3±3.23 in the laboratory condition on fresh bean (*Lablab purpureus* L.) (Mondal & Ara 2006). According to Razmjou *et al.* (2009b) finding the mean number of eggs laid and the lifetime of *T. urticae* was 34.50 eggs/female and 14.10 days respectively on bean that lower than the our results in this study. These results complemented previous studies, demonstrating variation in mite performance on different cultivars of the same crop. The use of crop cultivars that support only low pest population growth or even resistant varieties is an important part of integrated pest management (IPM) (Razmjou *et al.* 2009c). An important goal of future research will be to compare the varieties susceptibility to two-spotted spider mite with other economically relevant traits.

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## تأثیر ارقام مختلف لوبیا بر پارامترهای جدول زندگی کنه تارتن دولکه‌ای *Tetranychus urticae* Koch (Acari: Tetranychidae)

سید سعید مدرس نجف‌آبادی و عباس‌علی زمانی

### چکیده

تأثیر کیفیت میزبان مورد تغذیه، روی بقا و رشد و نمو کنه تارتن دولکه‌ای (*Tetranychus urticae* Koch) به خوبی اثبات شده است. در این پژوهش، پارامترهای زیستی (جدول زندگی) کنه تارتن دولکه‌ای، روی شش رقم مختلف لوبیا (شامل چیتی محلی خمین، چیتی Ks21189، قرمز اختر، قرمز Ks31169، سفید پاک و سفید G11867)، در شرایط ثابت (دمای  $25 \pm 2$  درجه سلسیوس، رطوبت نسبی  $70 \pm 5$  درصد و ۱۶:۸ ساعت روشنایی: تاریکی) طی سال‌های ۱۳۸۹–۱۳۹۰، مورد مطالعه قرار گرفت. نتایج نشان دادند که مدت زمان کل رشد و نمو مراحل نابالغ در کنه‌های نر و ماده، تحت تأثیر

ارقام مختلف لوبیا، دارای اختلاف معنی دار هستند. تعداد تخم گذاشته شده در روز توسط هر کنه ماده، به طور معنی داری در لوبیا قرمز اختر ( $1/25 \pm 1/16$  تخم/ماده/روز) نسبت به سایر ارقام بیشتر بود. میانگین مدت زمان یک نسل در کنه تارتن دولکه‌ای از  $23/37$  تا  $34/82$  روز و درصد تفریح تخم در این کنه، از  $85/25$  تا  $94/20$  درصد، بین ارقام مختلف لوبیا متفاوت و دارای اختلاف معنی دار هستند. همچنین بالاترین میزان نرخ ذاتی افزایش جمعیت  $r_m$  در لوبیا قرمز اختر ( $0/269 \pm 0/031$  ماده/ماده/روز) و پایین‌ترین میزان نرخ  $r_m$  ( $0/129 \pm 0/048$  ماده/ماده/روز) در لوبیا سفید پاک مشاهده شد. افزون بر این نتایج نشان دادند که بیشترین مقدار نرخ خالص تولید مثل ( $R_0$ ) و نرخ متناهی افزایش جمعیت ( $\lambda$ ) به ترتیب با  $62/38 \pm 1/05$  و  $1/30 \pm 1/02$  در کنه‌های پرورش یافته روی لوبیا قرمز اختر است. این در حالی است که کمترین مقدار  $R_0$  و  $\lambda$  به ترتیب با  $27/37 \pm 1/40$  و  $1/13 \pm 1/10$  در کنه‌های پرورش یافته روی لوبیا سفید پاک مشاهده شده است. مدت زمان دوبرابر شدن جمعیت کنه ( $DT$ ) نیز در ارقام لوبیا دارای اختلاف معنی دار بود و کمترین و بیشترین مقدار آن به ترتیب در لوبیا سفید پاک و لوبیا قرمز اختر مشاهده شد. نتایج این پژوهش نشان داد که ارقام سفید لوبیا (پاک و G11867) ارقام نامناسب و مقاومی برای رشد و نمو کنه تارتن دولکه‌ای هستند.

**واژگان کلیدی:** کنه تارتن دولکه‌ای، رشد و نمو، جدول زندگی، ارقام لوبیا

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