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Comparative development, reproduction and life table parameters of three populations of *Thrips tabaci* (Thysanoptera: Thripidae) on onion and tobacco

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Abstract

An investigation was carried out to study the developmental time, reproduction and life table of three populations of the onion thrips, *Thrips tabaci* Lindeman, on onion (Khorasan and Golestan populations) and also on tobacco (Mazandaran population) in the laboratory at 25°C, 50% RH and 16: 8 h L: D. The total life cycle from egg to adult of Khorasan, Golestan and Mazandaran populations were gauged as 15.22, 14.66 and 17.82 days, respectively. However, theses populations showed 30%, 38% and 58% immature mortality, respectively. The females of *T. tabaci* laid 29.5, 27.7 and 26.3 eggs averagely, and had a mean longevity of 18.0, 17.78 and 19.07 days in Khorasan Razavi, Golestan and Mazandaran populations, respectively. The net reproductive rate (R_0) was 19.75, 18.48 and 10.84, and the intrinsic rate of increase (r_m) was 0.143, 0.141 and 0.096 in Khorasan Razavi, Golestan and Mazandaran populations, respectively. Khorasan Razavi and Golestan populations (both reared on onion) had similar developmental time, mortality and life table parameters, while Mazandaran population (on tobacco) yielded significantly different values. Based on the differences of development, fecundity and life table parameters, there might be two distinct populations exploiting onion and tobacco in Iran.
Key words: *Thrips tabaci*, population, biology, onion, tobacco

چکیده

طول دوره‌ی رشد، تولید مثل و پارامترهای جدول زندگی سه جمعیت تریپس پیاز، *Thrips tabaci* Lindeman، شامل خراسان رضوی و گلستان روی پیاز و مازندران روی توتون در شرایط آزمایشگاهی (دمای ۲۵ درجه‌ی سانتی‌گراد، رطوبت نسبی ۵۰ درصد و طول دوره‌ی روشنایی به تاریکی ۱۶ به ۸ ساعت) مطالعه شد. طول دوره‌ی زندگی از تخم تا مرحله‌ی بلوغ در جمعیت‌های خراسان رضوی، گلستان و مازندران به ترتیب برابر با ۱۵/۲۲، ۱٤/٦٦ و ۱۷/۸۲ روز بود. مرگ‌ومیر پیش از بلوغ در این سه جمعیت به ترتیب برابر با ۳۰، ۳۸ و ۵۸ درصد بود. افراد ماده‌ی جمعیت‌های خراسان رضوی، گلستان و مازندران به ترتیب میانگین تخمی برابر با ۲۹/۵، ۲۷/۷ و ۲٦/۳ عدد تخم و میانگین طول عمری برابر با ۱۸/۰، ۱۷/۷۸ و ۱۹/۰۷ روز داشتند. نرخ خالص تولیدمثل (R_0) در جمعیت‌های فوق به ترتیب ۱۹/۷۵، ۱۸/٤۸ و ۱۰/۸٤ و نرخ ذاتی رشد (r_m) به ترتیب ۰/۱٤۳، ۰/۱٤۱ و ۰/۰۹٦ بود. جمعیت‌های خراسان رضوی و گلستان (هر دو روی پیاز) دوره‌ی رشدی، مرگ‌ومیر، و پارامترهای جدول زندگی مشابهی داشتند در حالی‌که جمعیت مازندران (روی توتون) از نظر ویژگی‌های فوق، اختلافات معنی‌داری با آن‌ها داشت. بر اساس اختلافات موجود بین طول دوره‌ی رشد پیش از بلوغ، باروری و پارامترهای جدول زندگی، ممکن است دو جمعیت مجزا از این آفت روی توتون و پیاز در ایران وجود داشته باشد.
واژگان کلیدی: تریپس پیاز، جمعیت، زیست‌شناسی، پیاز، توتون

Introduction

The onion thrips, *Thrips tabaci* Lindeman, is a polyphagous species with a world-wide distribution. It is a major pest of cultivated plants in Iran, such as alliaceous crops (onion, garlic and leek) and Cucurbitaceae (cucumber, pumpkin, melon and watermelon) (Modarres

Awal, 2001). The pest damage includes reduction of yield and fruit quality as well as virus transmission. The insect has been known as a vector of Tomato Spotted Wilt Virus (TSWV) (Zawirska, 1976) and was recently recognized as a transmitter of a new tospovirus, Iris Yellow Spot Virus (IYSV) (Doi *et al*., 2003). The resistance of the onion thrips to a wide range of insecticides both in greenhouses and field crops was reported in the United States (Shelton *et al*, 2003), Canada (Allen *et al*, 2005) and Japan (Murai, 2004).

The growing importance of *T. tabaci* warrants more quantitative research, not only to provide broader prospective on the biological and economic problems posed by this pest but also to gain insight into appropriate management strategies. Several life history studies have been published on *T. tabaci* (e.g. Sakimura, 1932; Watts, 1934; Harris *et al.*, 1936; Ghabn, 1948; Lall & Singh, 1968; Gawaad & El-Shazli, 1969; Lewis, 1973; Edelson & Magaro, 1988; Ananthakrishnan, 1993). Most of these studies lack age-specific data, needed for an accurate estimation of intrinsic rate of increase (r_m). van Rijn *et al*. (1995), Hassanzadeh Salmasi *et al*. (2003) and Madadi *et al*. (2006) presented information on life cycle, life table parameters and the habits of onion thrips on a number of hosts including onion, cucumber, sweet pepper and eggplant. Population trends of the onion thrips on onion was discussed by Bagheri (2000).

Zawirska (1976) reported that there were several strains of *T. tabaci* with different host preferences. Jenser *et al*. (2001) used the method of RAPD-PCR and found genetic differences between two populations collected from tobacco and onion. Based on sequences of the mitochondrial cytochrome oxidase subunit I (COI) gene in some European populations of *T. tabaci*, Brunner *et al*. (2004) reported that onion thrips must be a complex of cryptic (sub)species in association with host preference. Recently, Toda & Murai (2007) used mitochondrial gene sequence (COI) and found apparent differences between arrhenotokous and thelytokous strains of *T. tabaci*.

We designed a three phased project. In the first and second phases, the morphometric and molecular data of 18 populations of *T. tabaci* collected from different parts of Iran were studied. The results of both studies showed that there were two distinct populations of *T. tabaci* for each of the crops of onion and tobacco. However, a population collected from Golestan province on tobacco showed morphometric and molecular characteristics similar to populations collected from onion (unpublished data). To confirm these results we went on the third phase to compare the development, reproduction and life table parameters of the three populations of *T. tabaci* on onion and tobacco.

The ability of feeding, growing and reproducing are indices of the ability of an insect to colonize a host (McCauley *et al.*, 1990). Moreover, demographic analysis has been applied in studies of other arthropod pests to elucidate population dynamics and potential for host colonization (Carey, 1982; Krainacker *et al*., 1987). For instance, the basic life table techniques were used by Omer *et al.* (1992) to examine longevity, generation time and fecundity of two populations (organphosphate resistant and susceptible) of greenhouse whitefly, *Trialeurodes vaporariorum* (Westwood). These techniques have not been brought to bear on different populations of onion thrips. Therefore, this research was undertaken to systematically examine onion thrips demography using three populations of onion thrips. The objectives were: (1) quantification of pre-adult survival and development, (2) determination of life table parameters of adults, (3) analysis of reproduction, and (4) determination of population parameters.

Materials and methods

Three populations of *T. tabaci* were studied: (1) one population collected from onion (cv. Azarbaijan) in Shirhesar, Khorasan Razavi; (2) two other populations collected from tobacco (cv. Barly) in Aliabad, Golestan and Darab Kolah, Mazandaran, respectively. Each population reared separately on the foliage of respective hosts in glass-framed rearing cages (80 × 60 × 60 cm) covered using white nylon mesh of 210 µm apertures. The cages were maintained in a growth chamber (25 ± 2ºC, RH 60% and 16: 8 h L: D). Severely damaged plants in the cages were swapped with new ones if necessary.

Development time and mortality

The developmental time and mortality of different populations of *T. tabaci* were studied by confining 30 to 50 adult thrips of different ages beneath the plant leaves using a clip cage as described by Costa *et al*. (1991). For each population 4 clip cages were studied. The three populations reared on plant hosts were as follows: (1) Khorasan Razavi on onion, (2) Mazandaran on tobacco, and (3) Golestan on both onion and tobacco. The females were allowed to lay eggs for 24 hour. Afterward, the thrips and cages were removed and each part of leaf harbouring eggs (leaf disc) was kept in a Petri dish (8 cm diameter) over a wet tissue paper. One opening (2.5 cm in diameter) had already been made on the top side of each Petri dish that covered by nylon mesh for ventilation and the lid of the Petri dishes was secured using parafilm to prevent escapes. The Petri dishes were immediately transferred to a growth

cabinet at 25 ± 2 ºC, 45 to 55% RH and 16: 8 h (L: D). The entire leaf discs were regularly examined under a stereomicroscope to determine the number of eggs hatched each day. Since the eggs hatch inside the leaves, the beginning of the first larval stage was resolved by emergence of a larva on the leaf surface. The transition from first to second larval stage was determined by moulting phenomenon on the leaf disc, because there was not any significant morphological difference between two stages. The pre-pupae were recognized by their short wing sheaths and erect antennae. The pupae have long wing sheaths which almost reach the end of the abdomen, whereas the antennae are bent backward along the head. As soon as eggs hatched, each first instar larva was put individually on a fresh leaf disc, which was again replaced during the second larval stage. Each leaf disc was considered as a replication. The discs were not replaced for the duration of the pre-pupal and pupal stages. The development of immature stages was monitored with a dissecting microscope until adult emergence. The length of immature stages and mortality were recorded daily. The percentage mortality of each immature stage was calculated as:

$$\frac{\text{Number of dead insects in each immature stage}}{\text{Initial number of insects in each immature stage}} \times 100$$

Longevity, fecundity and life table parameters

Longevity, fecundity and other population parameters of different populations of *T. tabaci* were studied by transferring (using a 000 paintbrush) 14 females immediately upon emergence individually over leaf discs kept on a wet tissue paper in a Petri dish (8 cm in diameter). Each Petri dish was considered as a replication. All Petri dishes were incubated at the mentioned conditions. Thrips were transferred to a new leaf disc and the number of eggs laid was counted daily till females died.

Analysis of variance (ANOVA) and Duncan multiple range test were used to determine the developmental time, longevity and fecundity of thrips populations (SPSS, 2007). The longevity, daily fecundity, developmental period and survival of immature stages data were used to construct age specific survival and fecundity tables and to calculate net reproductive rate (R_0), intrinsic rate of increase (r_m), finite rate of increase (λ), mean generation time (T) and population doubling time (DT) (Southwood, 1978). The jackknife technique was used to estimate SE for the r_m values in different populations (Maia *et al*., 2000). The significance of

differences among the mean values of life table parameters was determined using ANOVA test (Maia *et al*., 2000; SPSS, 2007).

Results

Development time

The specimens of *T. tabaci* collected from Golestan did not complete their growth when reared on tobacco. However, they were able to survive and reproduce on onion. There were significant differences in developmental time among populations for the egg ($F = 8.94$; $df = 2, 177$; $P = 0.000$), first larval instar ($F = 13.85$; $df = 2, 149$; $P = 0.000$), second larval instar ($F = 45$; $df = 2, 134$; $P = 0.000$), pre-pupal stage ($F = 26.62$; $df = 2, 119$; $P = 0.000$), pupal stage ($F = 30.21$; $df = 2, 104$; $P = 0.000$), and the overall developmental time ($F = 63.86$; $df = 2, 104$; $P = 0.000$) (table 1). However, it was revealed that there was no significant difference in total developmental times between the Khorasan Razavi and Golestan populations (15.22 and 14.66 days, correspondingly). The longest duration of the developmental period (19.50 days) was recorded for Mazandaran population reared on tobacco.

Table 1. The pre-adult developmental time (in days) (mean ± SE) of different populations of *T. tabaci* reared on onion and tobacco at 25ºC, 50% RH and 16: 8 L: D.

	Population		
	Khorasan Razavi (onion)	**Golestan (onion)**	**Mazandaran (tobacco)**
Egg	4.97 ± 0.07a	4.63 ± 0.09a	5.11 ± 0.07b
Range	(3.5-6.5)	(3.5-6)	(6-4)
Instar I	2.28 ± 0.06a (n = 60)	2.21 ± 0.05a (n = 60)	2.71 ± 0.08b (n = 60)
Range	(1.5-3)	(1-3)	(2-4)
Instar II	3.11 ± 0.06a (n = 54)	2.89 ± 0.07a (n = 54)	3.88 ± 0.07b (n = 44)
Range	(2.5-4)	(2-3.5)	(3-4.5)
Pre-pupa	2.08 ± 0.05a (n = 50)	2.07 ± 0.05a (n = 51)	2.61 ± 0.05b (n = 35)
Range	(1.5-2.5)	(1.5-2.5)	(2-3)
Pupa	2.69 ± 0.09a (n = 47)	2.92 ± 0.06a (n = 45)	3.68 ± 0.09b (n = 29)
Range	(2-3.5)	(2-4)	(3-4.5)
Total	15.22 ± 0.19a	14.66 ± 0.18a	17.82 ± 0.17b
Range	(13-17)	(12-17)	(15.5-19.5)

Means in a row followed by the same letter were not significantly different ($\alpha = 0.05$) (Duncan multiple range test).

Mortality

Table 2 shows the pre-adult mortality of *T. tabaci* in three different populations. There were significant mortality differences among populations in the second larval instar ($F = 8.37$;

df = 2, 6; P = 0.01) and total pre-adult stages (F = 20.81; df = 2, 6; P = 0.002). However, mortalities of the first larval instar (F = 2.94; df = 2, 6; P = 0.129), pre-pupal stage (F = 2.31; df = 2, 6; P = 0.180) and pupal stage (F = 0.378; df = 2, 6; P = 0.700) were not significantly different. It was revealed that there was no significant difference in total mortality between the Khorasan Razavi and Golestan populations (30.0 versus 38.33%). The minimum mortality (30%) occurred in Khorasan Razavi population.

Table 2. The pre-adult mortality percentage (mean ± SE) of different populations of *T. tabaci* on onion and tobacco at 25ºC, 50% RH and 16: 8 L: D.

	Population		
	Khorasan Razavi (onion)	**Golestan (onion)**	**Mazandaran (Tobacco)**
Instar I	10.50 ± 0.64a (n = 60)	10.00 ± 1.29a (n = 60)	16.66 ± 1.64a (n = 60)
Instar II	7.26 ± 0.38a (n = 54)	4.50 ± 0.68a (n = 54)	20.60 ± 0.95b (n = 44)
Pre-pupa	5.83 ± 0.82a (n = 50)	13.23 ± 0.93a (n = 51)	16.49 ± 1.02a (n = 35)
Pupa	10.66 ± 0.56a (n = 47)	10.43 ± 0.92a (n = 45)	13.53 ± 0.76a (n = 29)
Total	30.00 ± 0.64a	38.33 ± 0.74a	58.33 ± 0.74b

Means in a row followed by the same letter were not significantly different (α = 0.05) (Duncan multiple range test).

Pre-oviposition period and longevity

In the present study, the pre-oviposition period lasted 2.35, 3.0 and 2.50 days on Khorasan Razavi, Golestan and Mazandaran populations, respectively (table 3). No significant difference (F = 2.517; df = 2, 39; P = 0.94) was observed in pre-oviposition period of *T. tabaci* among the populations examined.

Table 3. The pre-oviposition period and adult longevity (in days) (mean ± SD) of different populations of *T. tabaci* on onion and tobacco at 25ºC, 50% RH and 16: 8 h L: D.

	Population		
	Khorasan Razavi (onion)	**Golestan (onion)**	**Mazandaran (tobacco)**
Pre-oviposition (n = 14)	2.35 ± 0.16a	3.00 ± 0.20a	2.50 ± 0.25a
Range	2-4	2-5	2-5
Total longevity (n = 14)	18.00 ± 1.03a	17.78 ± 1.54a	19.07 ± 1.51a
Range	12-30	14-27	9-29

Means in a row followed by the same letter were not significantly different (α = 0.05) (Duncan multiple range test).

On average, adults lived for 18.0, 17.78 and 19.07 days in Khorasan razavi (on onion), Golastan (on onion) and Mazandaran (on tobacco) populations, respectively (Table 3).

However, these differences in adult longevity were not significant (F = 0.246; df = 2, 39; P = 0.783). Minimum and maximum longevities of *T. tabaci* were 9 and 30 days in Mazandaran and Khorasan Razavi populations, respectively.

Fecundity

The observations revealed no significant differences in daily fecundity (F = 0.76; df = 2, 39; P = 0.475) and total fecundity (F = 0.44; df = 2, 39; P = 0.465) among populations (table 4). Maximum and minimum fecundity of *T. tabaci* were 45 and 8 eggs both in Golestan population on onion.

Table 4. The mean daily and total fecundity (mean ± SE) of *T. tabaci* on onion and tobacco at 25ºC, 50% RH and 16: 8 h L: D.

	Population		
	Khorasan Razavi (onion)	**Golestan (onion)**	**Mazandaran (tobacco)**
Mean daily eggs	1.56 ± 0.09a	1.57 ± 0.09a	1.41 ± 0.11a
Range	0-7	0-7	0-7
Mean total eggs	29.50 ± 2.24a	27.71 ± 2.83a	26.35 ± 1.93a
Range	12-41	8-45	11-35
No.	14	14	14

Means in a row followed by the same letter were not significantly different (α = 0.05) (Duncan multiple range test).

Life table parameters

The values for the different parameters of life table are shown in table 5. Fecundity and survivorship data reflect the highest R_0 of *T. tabaci* in Khorasan Razavi population and the lowest in Mazandaran population (fig.1).

Table 5. The life table parameters (mean ± SE) of different populations of *T. tabaci* on onion and tobacco at 25ºC, 50% RH and 16: 8 h L: D.

	Population		
	Khorasan Razavi (onion)	**Golestan (onion)**	**Mazandaran (tobacco)**
r_m	0.143 ± 0.003a	0.141 ± 0.003a	0.096 ± 0.00b
R_0	19.750 ± 1.588a	18.4854 ± 1.89a	10.842 ± 0.80b
λ	1.15 ± 1.58a	1.15 ± 1.51a	1.10 ± 1.51b
T	20.87 ± 0.35a	20.61 ± 0.56a	24.86 ± 1.18b
DT	4.84 ± 0.04a	4.89 ± 0.10a	7.23 ± 0.34b

Means followed by the same letter in a row are not significantly different (α = 0.05) (Duncan multiple range test).

The R_0 was 19.75, 18.48 and 10.84, and the r_m was 0.143, 0.141 and 0.096 in Khorasan Razavi, Golestan and Mazandaran populations, respectively (table 5). However, there were no significant differences in R_0 and r_m values between Khorasan Razavi and Golestan populations (0.143 versus 0.141 and 19.75 versus 18.48).

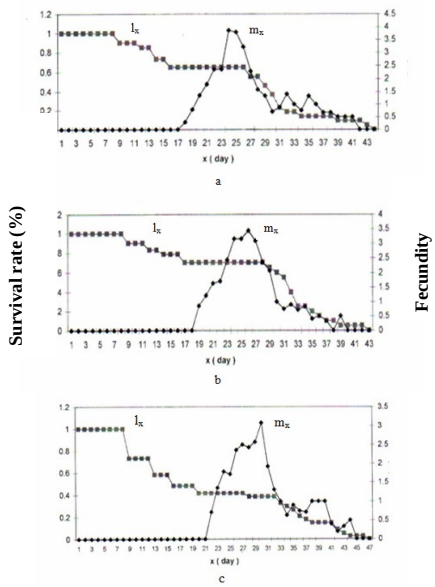

Figure 1. The age specific survival (l_x) and fecundity (m_x) of *T. tabaci* populations on onion (a, Golestan; b, Khorasan Razavi) and tobacco (c, Mazandaran), at 25ºC, 50% RH and 16: 8 h L: D.

Discussion

The immature developmental times of *T. tabaci* determined in the present study were longer in comparison to the ones reported in other studies conducted with similar constant temperatures. Bagheri (2000) found that developmental time of *T. tabaci* lasted 13.58 days on onion at 25°C. van Rijn *et al*. (1995) conducted a comparative study on cucumber (at 25°C) and found that total developmental times were slower generally (12.90 days), about 2-4 days slower than those obtained in this study. Hassanzadeh Salmasi *et al*. (2003) discovered that onion thrips reared on onion at 27°C completed their development in 11.06 days. Salas (1994) studied biology of onion thrips on onion (at 30ºC) and discovered that the developmental time

of this pest lasted 12.3 days. Harris *et al.* (1936) reported that developmental time from egg to adult lasted 11.2 days at 30ºC. The differences may be explained by disparities in host plant or population differences among the thrips.

As noted before the *T. tabaci* collected from Golestan province on tobacco could not survive on tobacco, while they survived and reproduced on onion. Furthermore, during samplings, no immature stages in the Golestan population were observed on tobacco. This shows once again that this population was unable to reproduce on this host plant. We hypothesize that this population has originally developed on onion but flight accidentally onto tobacco, or blown by wind or other means of transportation. Similarly, Zawirska (1976) reported that the effectiveness of *T. tabaci* as a vector for TSWV and host-plant preferences can vary dramatically among populations. Given this ecological diversity, Zawirska (1976) suggested that *T. tabaci* consist of two biotypes. The "tabaci type" is found on tobacco plants and is associated with the spread of TSWV. In contrast, populations of the "communis type" infest a variety of host plants (but not tobacco) and are not vectors for TSWV. Brunner *et al.* (2004) studied molecular characteristics of 22 populations of *T. tabaci* collected from tobacco and leek in Europe. Their results showed that *T. tabaci* represent a host-plant associated taxonomic complex comprising one tobacco group and two leek groups. They also found that while *T. tabaci* populations from both plants survived on leek, those originally collected from leek failed to survive on tobacco. Brunner *et al.* (2004) collected a small leek population on tobacco and argued that this host-mismatched adult thrips migrated to the tobacco fields accidentally. They mentioned that although thrips are week flyers, their fringed wings enable them to remain easily airborne long enough to travel between neighboring fields, and to be blown by the wind over far greater distances.

van Rijn *et al*. (1995) reported 19% pre-adult mortality for *T. tabaci* reared on cucumber that is lower in comparison to our results. They stated that the mortality occurred mainly during the larval period. They also discussed that most mortalities of relatively small *T. tabaci* was probably due to manipulation of the very young larvae.

At a constant temperature of 25°C, Bagheri (2000) found that the pre-oviposition period was 2.50 days on onion that is similar to our results. Hassanzadeh Salmasi *et al*. (2003) reported that the pre-oviposition period was 3.60 days on onion at 27°C that seems relatively high in comparison to our findings.

The longevity of female *T. tabaci* determined by the present study is similar to the one reported in another study conducted at a similar constant temperature (Bagheri, 2000).

Bagheri (2000) reported that at 25°C, females lived 17.27 days on onion. However, van Rijn *et al.* (1995) found that at 25°C females lived 11.9 days on cucumber that is lower than our results. Hassanzadeh Salmasi *et al*. (2003) found that females lived 16.15 days on onion at 27°C. The longevity of *T. tabaci* female was reported to be 59 days at 21ºC (Sakimura, 1937), 19.9 at 30ºC (Harris *et al.*, 1936) and 12-21 days at a fluctuating temperature with a mean of 30.8ºC (Lall & Singh, 1968).

The mean number of eggs laid per day in the present study may be compared with a study conducted by Hassanzadeh Salmasi *et al*. (2003) who found that the mean number of eggs laid by any female thrips on onion at 27 °C was 2.04 each day.

The total fecundity of onion thrips obtained in the current study is lower than values reported for this species. Bagheri (2000) reported that *T. tabaci* laid 36.82 eggs on onion at 25°C. Nevertheless, van Rijn *et al.* (1995) found that each female *T. tabaci* laid 27.5 eggs on cucumber at 25°C. Hassanzadeh Salmasi *et al*. (2003) discovered on onion plants at 27°C a mean of 31.63 eggs. Sakimura (1937) found also that *T. tabaci* deposited 80 eggs at 18ºC.

The values of R_0 and r_m of *T. tabaci* at 25°C on cucumber were found by van Rijn *et al*. (1995) to be 27.5 and 0.176, respectively. Madadi *et al*. (2006) reported that on cucumber, sweet pepper and eggplant the R_0 and r_m of *T. tabaci* were 81.58, 20.46 and 51.14, and 0.296, 0.158 and 0.234, respectively. The values for both parameters are higher in comparison to those found in the present study, reflecting lower juvenile mortality, higher fecundity and also longer adult life spans in the studies of van Rijn *et al*. (1995) and Madadi *et al*. (2006). Various factors, such as thrips population, host-plant and estimate methods may provide an explanation for lower R_0 and r_m values for *T. tabaci* in our study.

The importance of onion thrips as a serious pest in agricultural and greenhouse crops has increased worldwide in the past decades. The thrips reduces crop production by direct feeding damage and by vectoring TSWV. Due to difficulties in chemical control of thrips, several efforts have been focused on the development of integrated pest management (IPM) to control *T. tabaci*, especially on biological control techniques. Hence, as already discussed by Brunner *et al.* (2004), in order to make a reliable decision and reduce the application of pesticides, it is clear that the biology, ecology and population structure of *T. tabaci* (as herein presented) should be fully understood and its biotypes distinctly identified.

The observed differences in developmental time, mortality and reproduction quite likely indicate the presence of two *T. tabaci* biotypes in Iran. The results of this study also confirm the findings of our previous study (unpublished data) regarding the molecular and

morphometric information. Hence, one should consider the biotype of onion thrips when designing a pest management program for *T. tabaci* in Iran.

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