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Determination of the dominant spider mite (Acari: Tetranychidae) species on cotton fields in Golestan province, Iran

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Abstract. Cotton, *Gossypium hirsutum* L., is an important field crop which produces natural fibre. Cotton is produced around the world especially in Iran, regardless of the fact that every year many pests attack cotton plants which bring about significant damages. Spider mites are well- known significant pests of different crop species, particularly in cotton plants. Since Golestan is known as consequential cotton producing region, this research carried out to determine major species of spider mites. From 2008 to 2009, 50 cotton leaves were sampled from fields with different topography ranging from low-land, to foot-hill fortnightly. About 1000 slides were randomly prepared for microscopic identifications. Data indicated that *Tetranychus turkestani*, *Tetranychus urticae* and *Schizotetranychus* sp. included 52.27%, 40.80%, 6.91% of the spider mite populations, respectively. Thus, they could be the dominant pests in cotton fields. This finding is considered as a first step of the integrated pest management program in the target areas.

Key words: cotton, spider mites, dominant species, Golestan, Iran.

Introduction

Cotton is a valuable domesticated plant cultivated in more than 75 countries and over 40 million hectares of lands (Naseri 1995). Golestan, Khorasan, Fars, Azerbaijan are the dominant cotton producing regions in Iran (Akbarloo 2001). Approximately 33 species of spider mites are recorded around the world with different economic impact on cotton plants (Helle & Sabellis 1985). Tetranychidae family is group well-known spider mites which include the most of injurious plant feeding pests in Iran (Sepasgozarian 1977). They often attack field crops, fruit trees, and ornamental flowers rendering a lot of yield losses (Sepasgozarian 1977, Modarrese-Avval 2001, Haji-Ghanbar 2004, Khanjani & Haddad Irani-Nejad 2006). Two spotted spider mite, has a definite role in crop losses due to global distribution, broad host range, high damage intensity, resilient reproductive ability to inducing resistance against insecticides (Nicholls et al. 1998). In West Africa *T. urticae* and *T. ludeni* are main Tetranychid mites damaging leafy vegetable crops (Adango et al. 2006). Some genera of spider mites such as *T. cinnabarinus* (Boisdv), *T. turkestani* (Vgar and Kik) and *T. ludeni* (Zacher), were recognized on cotton causing a rapid leaf falls and finally plant death. Usually more than one species exist in different cotton producing regions during any time-period (El-Hamid et al. 1986, Meyer 1981). In the study of Honarparvar (2010) five mite species were collected from various regions of Hamadan. Among them *T. urticae*, *T. turkestani* and *Petrobia latens* were abundant and had vast distributions. Moreover, it is reported that *Petrobia latens* has been found on crop fields especially on wheat fields with a high occurrence and may has become a serious pest in future (Boland Andam et al. 1991, Atamehr 1997). Likewise, Steinkraus & Zawislak (2000) found some species on cotton in Arkansas among them *Tetranychus urticae*, *T. desertorum*, *T. turkestani* and *T. cinnabarinus* had the highest populations also, *T. turkestani* was the most injurious species. Furthermore, *Tetranychus urticae* was found in South Africa (Smith-Meyer 1974) and in Australia (Wilson et al. 1997) has been presumed as a damaging pest in cotton fields. Majority of acaricides have been negated by spider mites, they could develop inheritable resistance within a few years (Field & Hoy 1986). It seems that chemical controls have not absolutely been effective on spider mites; therefore, other approaches would be necessary in field management. As a matter of fact, spider mites are mostly recorded in Iran nonetheless; this study revealed predominant spider mites for the first time of cotton fields in Golestan province. Thus, comprehensive identification of different species spider mites on cotton field not only is the main objective of this study but it also is required to define efficiency of their natural enemies. This study reinforces our strategic and establishes integrated pest management of cotton fields in this province.

Materials and Methods

Golestan province is located in south-east Caspian Sea. This area covers around 20000 hectares of cotton fields. Figure 1 defines Gorgan, Gonbad Kavoos and Aliabad-e Katul are the most remarkable regions where spider mites are studied. Owing to the fact that above-mentioned places are the most consequential areas aspect of cotton cultivation (Forghani 2005), our studies focused on those locations. Gorgan has mediocre climate with warm and sultry condition in the summer. The mean of annual rainfall 214 mm and mean temperature is 17 ºC. In addition, Altitude, longitude and latitude are respectively 155 m, 54°28'48" and 36°49'48". Gonbad-e Qabus (Gonbad Kavoos) has a moderate and humid climate. The annual mean temperature and rainfall are about 11.4 ºC and 500mi furthermore, altitude, longitude and latitude are assigned 52 m, 55°10'17" and 37°15'18". Nearly, there is the same climate mentioned of Goragan in Ali Abad-e Katul with 15.5 ºC for annual temperature and rainfall 500-600mm. It is supposed that 140m as altitude, longitude 36°56'30" and latitude 54°34'18". Sampling and identifying were conducted in cotton fields, every two weeks for three regions including plain (Gorgan), semi-plain (Gonbad kavoos) and foot-hill (Ali Abad-e Katul) during the growing seasons between 2008- 2009. Field conditions were constant in respect of irrigation, manure and non-chemical control. Fifty leaves from each field (Sirjani & Arbabi 2005, Steinkraus et al. 2003) were randomly collected from mid-May up to the harvest (early Oct.). The leaves were collected from different stem sections (up, down, middle) and were placed in plastic bags. They were transferred to the lab and stored in a refrigerator (temperature of 2 ºC) for

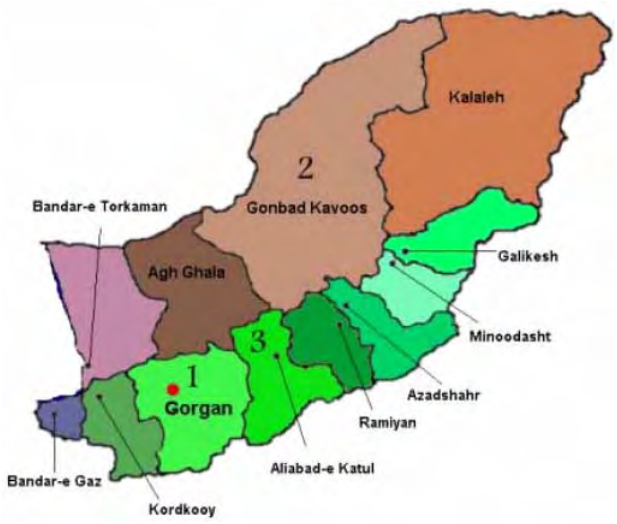

Figure 1. Golestan province map.

1-3 hours (Sirjani & Arbabi 2005). Then, all stages of active mites were collected from back of the leaves and stored in certain tubes containing 75% alcohol and 5% glycerine. About thousand specimens of adult mites randomly prepared for identification under a dissecting microscope with magnification of 70X according to the renowned procedure (personal communication, Khanjani Prof. Bu Ali-Sina University, Iran) and then, types of mite species were identified. SPSS (2007) software is used for data analysis using one-way ANOVA. If significant differences were detected, multiple comparisons would be made using Tukey's multiple range test ($P< 0.05$).

Results

Population of the spider mites showed fluctuations in Golestan province during the sampling duration (Table 1). It can be clearly seen that the number of mite species considerably varied every year. In first year, *T. turkestani* and *Schizotetranychus* sp. showed an increase mite number toward second half of the year. However, these condition were opposite for *T. urticae*. Moreover, our findings showed that during both years, the mean number of *T. turkestani*, was larger than that of *T. urticae* and *Schizotetranychus* sp. Likewise, the mean number of spider mites in each place was indicated (Table 2). On the whole, the average number of the mites increased in Gorgan while in Gonbad Kavoos it was dropped. *Tetranychus turkestani* was in the peak population frequency; nevertheless, *Schizotetranychus* sp. was the lowest. The greatest population size of *T. turkestani* is discovered in Gorgan but the lowest is in Ali Abad-e Katul. However, the highest and lowest population range of *Schizotetranychus* sp. was found in Ali Abad-e Katul and Gonbad Kavoos. In addition, *T. urticae* ranked the second mite in respect to the mite population in these regions.

Identified species

Prepared specimens were classified according to Khanjani and Haddad Irani-Nejad (2006) up to the genus according to Prof. Mohammad Khanjani (Acarologist in Bu Ali-Sina University, Hamedan, Iran). Also, these mite species drew with different parts of their bodies.

Tetranychus turkestani

This mite causes orange to bright red colour on cotton leaves. As a result, it reduces photosynthesis; finally leaves begin to fall. Aedeagus, which is in fact male genital organ, is typical to recognize for Tetranichids. Knob of male aedeagus was very large, broadly rounded interiorly and sharply posteriorly angled. *Tetranychus turkestani* has a close resemblance to *T. urticae* aspect of taxonomical. However, there was a difference between them in their aedeagus male. As in *T. urticae* ratio of knob length to back ward length of aedeagus was one-sixth, while in *T. turkestani* was one-third

Table 1. Turkey multiple range test for adult of spider mites (Tetranychidae) on Sahel cultivar cotton in 2008-09 (N= 1000).

Year	Species	Mean±SD	%
2008	*T. turkestani*	312.33 ± 21.03 a	55.12
2008	*T. urticae*	212.00 ± 29.13 b	37.45
2008	*Schizotetranychus* sp.	41.67 ± 14.57 c	7.32
2009	*T. turkestani*	284.67 ± 30.17 a	49.42
2009	*T. urticae*	254.00 ± 25.23 ab	44.09
2009	*Schizotetranychus* sp.	37.33 ± 12.00 c	6.48
2008-2009	*T. turkestani*	298.50 ± 27.76 A	52.27
2008-2009	*T. urticae*	233.00 ± 33.52 B	40.80
2008-2009	*Schizotetranychus* sp.	39.50 ± 15.83 C	6.91

Means followed by the same letters within column are not significantly different by Tukey's multiple range test ($P< 0.05$).

Table 2. Mean number (Mean±SD) of spider mites in three different parts of Golestan, Iran (2008-09).

	T. turkestani	*T. urticae*	*Schizotetranychus* sp.
Gorgan	112.83 ± 8.56 a	79.17 ± 11.01 b	12.5 ± 5.46 c
Gonbad kavoos	95.50 ± 9.39 a	68.83 ± 10.72 b	11.17 ± 5.03 c
Ali Abad-e Katul	90.17 ± 12.33 a	85.00 ± 18.05 a	15.83 ± 5.52 b

Means followed by the same letters within rows are not significantly different by Tukey's multiple range test ($P< 0.05$).

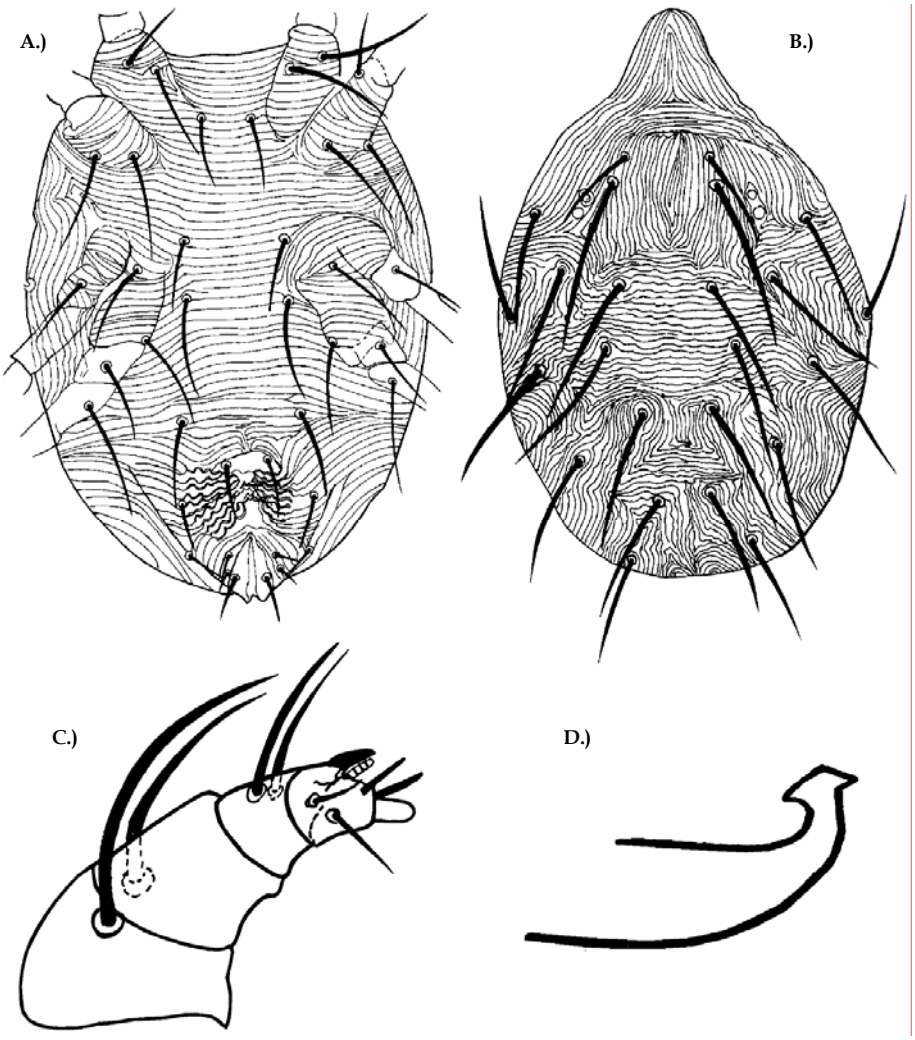

Figure 2. *Tetranychus turkestani:* **A.)** the dorsal surface; **B.)** the abdominal surface; **C.)** female palpus; **D.)** male aedeagus (original).

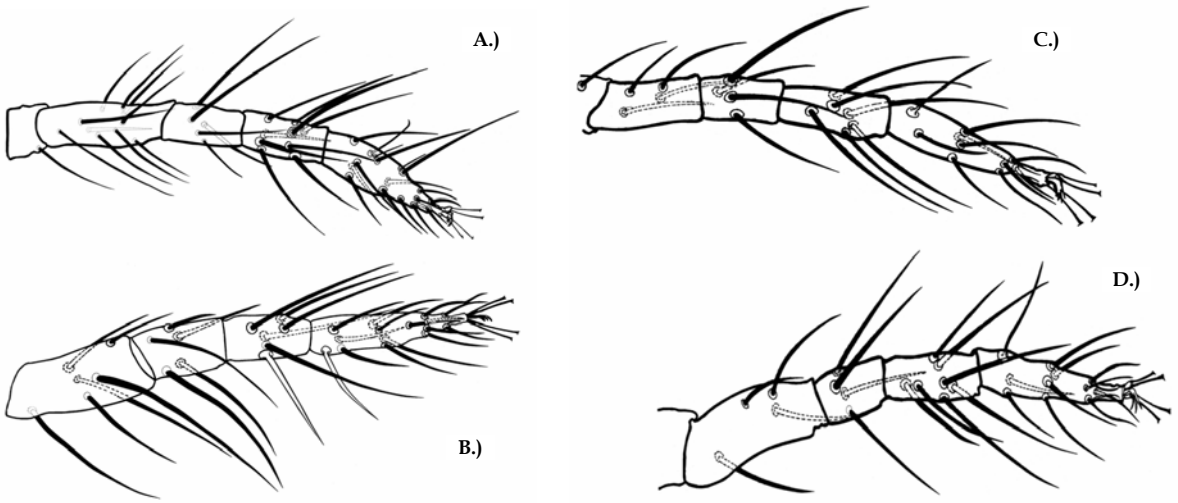

Figure 3. Female of *Tetranychus turkestani*: **A.)** the first leg; **B.)** the second leg; **C.)** the third leg; **D.)** the fourth leg (original).

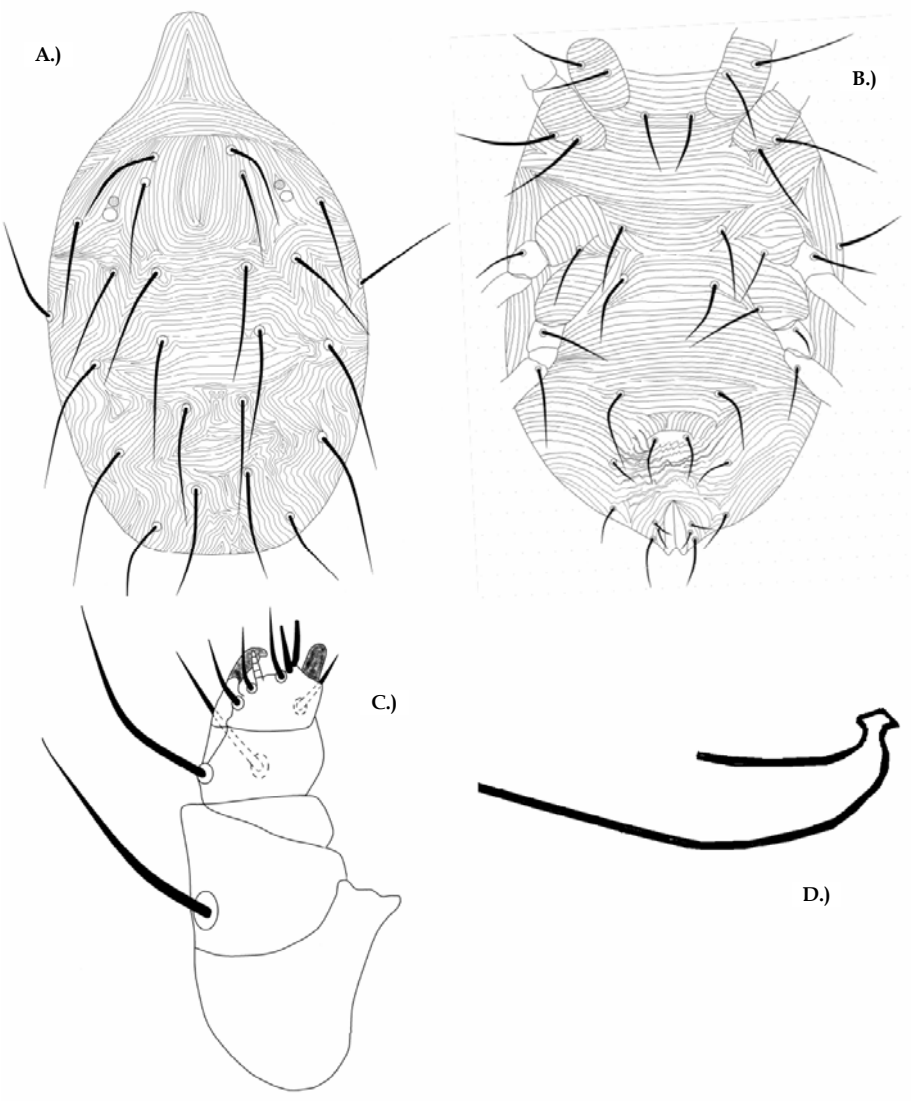

Figure 4. *Tetranychus urticae*: **A.)** the dorsal surface; **B.)** the abdominal surface; **C.)** female palpus; **D.)** male adeagus (original).

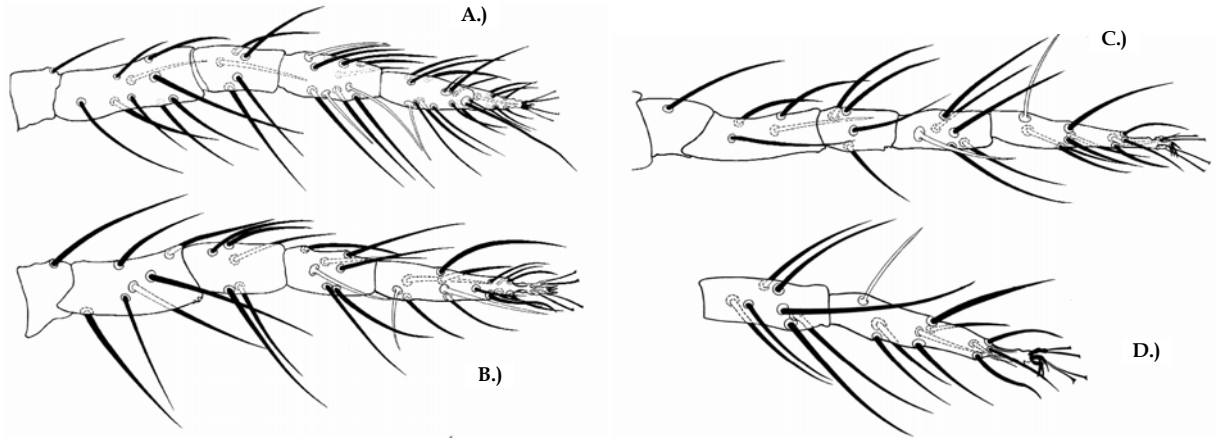

Figure 5. *Tetranychus urticae* female: **A.)** the first leg; **B.)** the second leg; **C.)** the third leg; **D.)** tibia and tarsus of fourth leg (original).

(Tuttle & Baker 1968, Jepson et al. 1975) (Fig. 2). Empodium on tarsus of first leg is claw like with hair back spine like. The length of this hair is two-third in length of abdominal empodium hair. Spine empodium hair on pretarsi of second leg is two-third and bigger than spine of empodium hair in third and fourth leg pretarsi (Fig. 3).

Tetranychus urticae

Among spider mites, *T. urticae* was ranked the second in respect of the mite population in the cotton fields. Females had oval shape, length to width size of 500 microns and 300 microns, its colour ranges from brown red to green, with a dark stain on the side on the middle idiosoma (Fig. 4). The most important characteristic for identification of this species was the external organs of male genitalia (aedeagus) (Fig. 4). Legs were bright yellow in this mite (Fig. 5).

Discussion

During the two years of studies, survey on different populations of spider mites revealed that *T. turkestani* had the highest number of population. On the other hand, *T. urticae* had a lower population size and *Schizotetranychus* had the lowest numbers in cotton fields of Golestan province. Although, others different research were conducted on spider mites in various field crops across Iran, however, there were not report of population estimation or statistics to introduce predominant spider mites in cotton fields. In this regard, *T. turkestani* (Ugarov & Nikolski) were collected from various provinces and climate condition of Iran such as: Ardebil, Isfahan, Hamedan, Kerman, Chahar Mahale va Bakhtiari, Khuzestan, West Azarbaijan, Tehran (Khalil Manesh 1972, Sepasgozarian 1977, Daneshvar 1977, Fatemi 1982, Kamali 1989, Khanjani & Kamali 1993, 1998, 2000), Also, Bayat-asadi et al. (2006) observed the remarkable population of *T. turkestani* on different cotton cultivars in Gorgan.

In addition, *T. urticae* existed in Gorgan, Ramsar, Bandar Anzali, Tehran, Golestan, Azerbaijan, Kordestan, Hamedan, Ardebil, Kermanshah, Markazi and were collected from some fruit trees and field crops (Khalil Manesh 1972, Khanjani & Haddad Irani-Nejad 2006 Forghani 2005, Moddares Avval 2001, Farah Bakhash 1961, Haji Ghanbar 2004, Davachi & Taghizadeh 1951, Sepasgozarian 1977). In addition, *Schizotetranychus* was reported in Fars, Azerbaijan, Khorasan, Hamedan and Golestan on sallow, apple, pear trees and cotton (Modarrese-Avval 2001, Khalil-Manesh 1972, Forghani 2005, Honarparvar 2010, Atamehr 1997, Sepasgozarian 1977, Behdad 1992).

All of these species were mainly collected from many regions around the world including cotton fields and other crop plants (Smith-Meyer 2001). Similarly, above mentioned mites infest wide range of host plants in Iran like Beans, strawberries, cotton, eggplant, soybean, sugarcane, sunflower, castor, alfalfa, clover and some vegetables and herbs (Shishehbor 1989, Sadeghi Namqy 1990, Farid & Daneshvar 1995). Moreover, the mean difference was noticeable, between population size of *Tetranychus* species in Gorgan and Gonbad Kavoos rather than Ali Abad Katol (Table 2). Thus, the differences could be attributed to the mite characteristic, climatic conditions, type of host plants and their biochemical effects. This is due to the fact that every host plant has multiple effects on each pest (Gould 1979, Jesiotr 1979, Watson 1964, Wilson et al. 1991, Wilson 1994). It seems that condition for mite multiplications were more appropriate for *T. turkestani* and they were retarding for *Schizotetranychus* sp.

It is apparent that for two years population size of *T. turkestani* faster increased compared to the others. Then, it seems that *T. turkestani* is the dominant mite in cotton fields in this region of Iran. Also, in other parts of the world different mites have been reported with high frequencies of occurrences. As a case in point, in Australia *Petrobia* latens; in the southeast of Asia *Eutetranychus orientalis*; in Mexico *T. pacificus* and *T. urticae* and the species, *T. lambarsini* in East Africa have been reported to be the most dominant pests on cotton (Meyer 1981, El-Sadany et al. 1977). Similarly, Helle and Sabelis (1985) recorded different mites in some parts of the world in cotton fields as followings: in Mozambique *T. ambicus*, in Egypt and Peru *Olionychus mangiderus*, in large part of northern hemisphere *T. turkestani* finally *T. pacificus* in Mexico and west of America. The same conclusions were reached by Bhagat and Singh (1999), Gulati (2004), Chinnah et al. (2007) and Chinnah et al. (2009) who believed that *T. urticae* was the major mite pest on eggplants whereas Silva et al. (1999) showed *T. ludeni* was more serious in cotton fields. According to various researches across the world, different mites were reported in cotton and other crops where mite characteristics or type of the host plants may be effective in their growths and activities. For instance, these conditions elevate plant size and quality which can influence mite dynamics (Rotem & Agrawal 2003). In addition, Tomczyk and Kropczynska (1986) emphasized that the feeding time and population densities of spider mites are contingent upon the length of their stylets and leaf characteristics of the host plants. Van de Vrie et al. (1972) confirmed that different plant species or cultivars may differently affect population size of Tetranichid mites, and these differences may be associated with the nutritional value of the host plants. Therefore, this study could provide guidance for others researches on evaluating the performance of the spider mites and the efficiency of its natural enemies in cotton fields under variable environmental conditions.

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