ECOLOGY, BIOLOGY AND CONTROL OF SOME MITES ASSOCIATED WITH WATERMELON AT QALUOBEIA GOVERNORATE

By

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ABSTRACT

Experiments were conducted at Qalubia Governorate to study the population fluctuation of the two spotted spider mite *Tetranychus urticae* Koch infesting four watermelon cultivars; Aswan, Daytona, Molokai and Giza-1 and associated natural enemies; and their response to environmental factors (temperature and relative humidity) during two successive seasons 2009 and 2010. In addition, the susceptibility of four watermelon cultivars to mite infestation was estimated. Also, biology and life table parameters of *T. urticae*, *Phytoseiulus persimilis* (Athias-Henriot) and *Neoseiulus californicus* (McGregor) were studied. The efficiency of (biological and chemical) two control methods against *T. urticae* during the two seasons were conducted. The results revealed the following:

Mite populations reached its peak during July and May in the first and second seasons, respectively, and infestation was lower in the first season and this might be due to early plantation in the second. The temperature and R.H. % positively affected population growth of *T. urticae* on Daytona and Molokai cultivars during the two seasons, while with natural enemies, it was insignificantly negative during the two successive seasons.

Aswan cultivar was the most highly susceptible recording average of 42.86 and 57.59 mite individuals/leaf during the two successive seasons, respectively, followed by the moderately infested cultivars (Daytona) recording 28.10 and 39.75 mite individuals. The lowest infestation was recorded on Molokai and Giza-1 cultivars, averaging 19.18 & 25.90 individuals/leaf for the former and 18.10 & 25.94 for the latter cultivar during the two successive seasons, respectively. Susceptibility of watermelon cultivars to infestation with *T. urticae* may be affected by plant leaf morphological structure and its chemical contents. The number of trichomes /cm² of leaf averaged 647.8, 744.4, 1111.1 and 1296.7 for Aswan, Daytona, Molokai and Giza-1 respectively; the less number of trichomes the more mite infestation. Positive relationships occurred between mite infestation levels and total amino acids, free amino acids, nitrogen and total soluble sugars in watermelon cultivars, while negative relationships found with tannins and nearly shown with total phenolic compounds, total flavonoids and total carotenes.

Watermelon cultivars and temperatures affected the life table parameters and duration of developmental stage as well as adult longevity and female fecundity of *T. urticae*, *P. persimilis* and *N. californicus*. Duration of female developmental stages being the shortest when rearing on leaves of Aswan cultivar at 30°C and the longest on leaves of Giza-1 cultivar at 25°C. Male showed similar trend as female with slightly shorter periods.

In biological control, Release of *P. persimilis* gave the highest reduction percentage with *T. urticae* movable stages, and the lowest reduction percentage with eggs during the two successive seasons. Also *N. californicus* seemed to prefer eggs of *T. urticae* than movable stages compared with *P. persimilis*. In chemical control, the highest reduction percentages were recorded with Envidor 24%SC and the lowest reduction percentages were recorded with Endo 50% during the two successive seasons.

Key words: Population dynamics, *Tetranychus urticae*, host plant resistance, life table parameters, biological control, chemical control, susceptibility, watermelon.
DEDICATION

Firstly, I dedicate this work to ALLAH and for serving my religion. Secondly, I wish to express my infinite thanks to my parents, my brothers, my sisters, and my wife for their help in finishing this work. Finally, to the one who made my life full of joy, the one whom I always love his smile; to my son Omar.
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INTRODUCTION

Watermelon plant *Citrullus lanatus* L. (Family: Cucurbitaceae) is considered one of the most important vegetable crops. It is preferred by consumers and considered an economic crop that has a high rank locally. Also, it constitutes a huge part of exported crops to Arab and European markets. Watermelon fruits endure shipping and storing treatments, so it can reach the markets safe and fresh.

In Egypt, watermelon plant can be produced throughout the year. It is grown in Lower Egypt during summer and in Upper Egypt during autumn. It is also cultivated in the valley and the new reclaimed lands under plastic tunnels with adjusted weather conditions. The cultivated area with watermelon (summer season) is in a continual decrease. It decreased from 157156 feddans in 2006 to 113828 feddans in 2009 (according to the Annual Report of Agric. Statistics Dept., Ministry of Agriculture, Egypt, from 2006 to 2009).

Watermelon is usually infested with several pests including the spider mites. *Tetranychus urticae* Koch (Farrag et al., 1984), *Tetranychus cinnabarinus* Boisd. (Mansour and Karchi 1994), *Tetranychus kanzawai* Kishida (Morishita and Yano, 1996), and the tarsonemid mite *Polyphagotarsonemus latus* Banks (Kousik et al., 2007).

In Egypt *T. urticae* is considered one of the most important pests causing economic damage to watermelon plants. Generally, spider mites prefer the undersides of leaves, but in severe infestation occur on both leaf surfaces as well as on the stems and fruits. They suck the sap of plant tissues, (Abdallah, 2002). Infestations are most serious in hot
and dry conditions, as the mite multiply very fast and able to destroy plants within a short period.

Evaluation of the susceptibility of some watermelon cultivars to infestation with *T. urticae* in order to select the less susceptible ones is considered important to avoid using more pesticides. Chemical contents and morphological characteristics which normally vary from plant variety to another, may affect the population levels of herbivorous pests. There were several studies on the host plant resistance to the infestation with *T. urticae*. (Ahmed, 1994; Tomczyk *et al.*, 1996; Hanafy, 2004; Lopez *et al.*, 2005; Jyotika, 2006; Ibrahim *et al.*, 2008; Abdallah *et al.*, 2009 and Afifi *et al.*, 2009).

Several methods were undertaken to control the spider mite *T. urticae* in cucurbitis of which chemical control was practiced by (Kilany, 1997; Kumar & Singh, 2003; Mahgoub, 2006; Gengotti *et al.*, 2008; Abdallah *et al.*, 2010 and Edwards *et al.*, 2010). Also, biological control received more attention by (Fejt and Jarosik, 2000; Heikal and Fawzy, 2003; Heikal *et al.*, 2003; Mahgoub, 2006; Abdallah *et al.*, 2010 and Sarwar *et al.*, 2011). It provided safe environment resulted in a reduction in pesticides application for about 60% for tomatoes and 70% for cucumbers, (Granges and Leger, 1998). Moreover, biological control can be used either alone or as a component of integrated pest management, (Heikal, 2010).

The objectives of this work are to study the following points.

1. The population fluctuations of the two-spotted spider mite, *T. urticae* infesting four watermelon cultivars and associated natural enemies in open filed at Qaluobeia governorate.
2. Evaluation the susceptibility of four watermelon cultivars to *T. urticae* infestation and the effect of the morphological leaf characteristics and its phytochemical components on the infestation rate.

3. Biology and life table parameters of *T. urticae* and its acarine predators *Phytoseiulus persimilis* (A.-H.) and *Neoseiulus californicus* (McGregor) reared on two watermelon cultivars leaves; Aswan and Giza-1.

4. Effect of releasing two predatory mite species, as well as effect of spraying two pesticides on *T. urticae* infesting four cultivars of watermelon at Qaluobeia governorate during two successive seasons; 2009 and 2010.
SUMMARY

Watermelon plant *Citrullus lanatus* L. (Family: Cucubitaceae) is considered one of the most important vegetable crops. It is preferred by consumers and considered an economic crop that has a high rank locally. Also, it constitutes a huge part of exported crops to Arab and European markets.

In Egypt, watermelon is usually infested with several pests (insects and mites) including the red spider mite, *Tetranychus urticae* Koch which is considered one of the most important pests causing economic damage to plants. Experiments were conducted at Qaluobeia governorate.

The results revealed the followings:

1. **Ecological studies**

   Four watermelon cultivars were chosen for this study. They were Aswan, Daytona, Molokai and Giza-1. These experiments were conducted during the two successive seasons; 2009 and 2010.

   a. **Population dynamics of the two spotted spider mite, *T. urticae* infesting four watermelon cultivars during 2009 and 2010 seasons**

   1. The infestation of watermelon cultivars; Aswan, Daytona, Molokai and Giza-1 with *T. urticae* started on the 4\(^{th}\) week of May then it gradually increased to reach its peaks in July during 2009 season, while in 2010 season, infestation started on the 2\(^{nd}\) week of March, then gradually increased to reach its peaks in May.
2. The highest numbers of *T. urticae* movable stages and eggs infestation averaged 98.25 & 47.45; 55.55 & 36.05; 45.85 & 31.9 and 33.45 & 26.15/leaf for Aswan, Daytona, Molokai and Giza-1 cultivars during 2009 season, respectively, while averaged 140.15 & 90.30, 94.45 & 63.45; 52.10 & 30.10 and 60.80 & 38.05/leaf during 2010 seasons, respectively.

3. The highest infestation was recorded on Aswan cultivar and the moderate infestation was recorded on Daytona cultivar, while the lowest infestation was recorded on Molokai and Giza-1 cultivars.

b. Population dynamics of natural enemies on four watermelon cultivars during 2009 and 2010 seasons

The population of natural enemies on watermelon cultivars; Aswan, Daytona, Molokai and Giza-1 averaged 0.33, 0.33, 0.25 & 0.27; 0.28, 0.12, 0.07 & 0.08 individuals/leaf during 2009 summer season and 2010 early summer season, respectively.

c. Effect of certain weather conditions on abundance of *T. urticae* infesting watermelon cultivars and associated natural enemies during 2009 and 2010 seasons

The temperature and relative humidity (R.H.%) positively affected population growth of *T. urticae* on Daytona and Molokai cultivars during 2009 and 2010 seasons, while on Aswan and Giza-1 cultivars, it had positive or negative effect. This effect on the abundance of natural enemies was insignificantly negative during the two successive seasons.
d. Host plant resistance

1. Susceptibility of four watermelon cultivars to *T. urticae* infestation during 2009 and 2010 seasons

   a. Aswan cultivar was the most highly significant susceptible to *T. urticae* infestation. It recorded 42.86 (39.60%) and 57.59 (38.60%) moving stages / leaf during the two successive seasons, respectively.

   b. The lowest infestation was recorded on Molokai and Giza-1 cultivars, being 19.18 (17.72%) and 25.90 (17.36%) individuals / leaf for the former; 18.10 (16.72%) and 25.94 (17.39%) individuals / leaf for the latter cultivar during the two successive seasons, respectively.

2. Effect of the morphological leaf characteristics on *Tetranychus urticae* infestation

   Susceptibility of watermelon cultivars to infestation with *T. urticae* may be affected by plant leaf morphological structure; Length, thickness and density of leaf trichomes. Average number of trichomes /cm² leaf were 647.8, 744.4, 1111.1 and 1296.7 for Aswan, Daytona, Molokai and Giza-1 cultivars, respectively.

3. Effect of some phytochemical components on the infestation rates of *Tetranychus urticae*

   The highest mean number of *T. urticae* movable stages occurred on the leaves of Aswan cultivar which associated with higher levels of total amino acids, total soluble sugars, total free amino acids and total nitrogen. This indicated a positive significant relationships with the population densities, while the reverse was true with total phenolic compounds, total flavonoids, total carotenes and tannins that indicated
negatively significant relationships with the population densities as the resultant throughout the growing season, whereas the opposite occurred with Giza-1 cultivar which exhibited the lowest infestation average of *T. urticae* movable stages, and this was associated with lowest levels of the above photochemical components.

2. **Biological studies**

The duration of developmental stages, life history, life span, fecundity of the spider mite *T. urticae* and the two predatory mites; *Phytoseiulus persimilis* Athias-Henriot and *Neoseiulus californicus* McGregor were carried out on leaves of two watermelon cultivars Aswan and Giza-1 which had the highest and the lowest infestation with *T. urticae* at two different temperatures 25±1°C and 30±1°C and constant R.H. (70%) at laboratory.

1. The two watermelon cultivars and two temperatures affected the duration of every developmental stage as well as adult longevity and female fecundity of *T. urticae, P. persimilis* and *N. californicus*. Duration of female developmental stages being the shortest when rearing on leaves of Aswan cultivar at 30°C and the longest on leaves of Giza-1 cultivar at 25°C. Male showed similar trend as female but with slightly shorter periods.

2. The shortest mean generation time (T) of *T. urticae* was 13.68 days on Aswan cultivar at 30°C, and the longest was 19.52 days on Giza-1 cultivar at 25°C. The highest net reproductive rate (*R₀*) and intrinsic rate of natural increase (*rₘ*) were 32.81 ♀/♀ & 0.255♀/♀/day on Aswan cultivar at 30°C
respectively, and the lowest were 15.04 ♀/♀ & 0.139♀/♀/day on Giza-1 cultivar at 25°C, respectively.

3. The shortest mean generation time (T) of *P. persimilis* was 12.40 days on Aswan cultivar at 30°C, and the longest was 16.41 days on Giza-1 cultivar at 25°C. The highest intrinsic rate of natural increase (*r_m*) was 0.285 ♀/♀/day on Aswan cultivar at 30°C, while the lowest was 0.217 ♀/♀/day on Giza-1 cultivar at 25°C.

4. The shortest mean generation time (T) of *N. californicus* was 12.72 days on Aswan cultivar at 30°C, and the longest was 18.59 days on Giza-1 cultivar at 25°C. The highest intrinsic rate of natural increase (*r_m*) was 0.241 ♀/♀/day on Aswan cultivar at 30°C, while the lowest was 0.174 ♀/♀/day on Giza-1 cultivar at 25°C.

3. **Control Studies**

   a. **Biological control of *Tetranychus urticae* Koch on watermelon**

   Two predatory mite species; *P. persimilis* and *N. californicus* were used to evaluate their efficiency against the phytophagous mite, *T. urticae* infesting four watermelon cultivars (Daytona, Giza-1, Aswan and Molokai) during the two successive seasons; 2009 summer season and 2010 early summer season in open filed at, Qaluobeia governorate. Acarine predator release started on 20th June during 2009 season, and 10th April during 2010 season. The used ratio between predator and prey was 1: 10. The results revealed the followings:

   1. Releasing *P. persimilis* and *N. californicus* gave highly reduction percentages (%) of *T. urticae* movable stages on Aswan, Daytona
and Molokai cultivars (96.41, 95.43& 94.85 and 94.32, 94.00 & 94.71%) during 2009 season respectively, while the lowest reduction percentages was on Giza-1 cultivar (86.37 & 84.05%)

2. The highest reduction percentages were recorded on Aswan cultivar (96.72 & 95.87), followed by the moderately reduction percentages on Daytona (92.55 & 90.93%), and the lowest reduction percentages on Molokai and Giza-1 (83.12 & 84.60 and 86.15& 82.56%) during 2010 season respectively.

3. Releasing of the two predatory mites; *P. persimilis* and *N. californicus* during 2009 and 2010 seasons gave the highest reduction percentages of *T. urticae* eggs on Aswan cultivar (93.97 & 94.21 and 93.15 & 95.11%), followed by the moderately reduction percentages on Daytona and Molokai (88.79 & 91.92 and 88.48 & 90.12%) and (86.21& 89.40 and 83.54 & 83.43%). The lowest reduction percentages were recorded on Giza-1 (80.84& 82.13 and 80.56 & 78.93%), respectively.

4. Release of *P. persimilis* gave the highest reduction percentages with movable stages of *T. urticae*, while it gave the lowest reduction percentages with eggs during the two successive seasons.

5. Physical factors affected the experiments and playing a role in differences between watermelon cultivars susceptibility to *T. urticae* infestation.

b. Chemical control of *Tetranychus urticae* on watermelon

The two pesticides (Envidor 24%SC as a biocide) and (Endo 50%
EC as a chemical compound), were used against *T. urticae* infesting four watermelon cultivars (Daytona, Giza-1, Aswan and Molokai) during 2009 summer season and 2010 early summer in open filed at Qaluobeia governorate.

The results revealed the following:-

1. Spraying two pesticide compounds; Envidor 24% SC and Endo 50% EC during 2009 season recorded high reduction percentages of *T. urticae* movable stages on Aswan and Daytona cultivars (69.50 & 63.99 and 63.62 & 56.68%), respectively, while recorded low reduction percentages on Giza-1 and Molokai cultivars (49.55 & 45.98 and 56.66 & 46.59%) respectively.

2. During 2010 season, they recorded the highest reduction percentages of *T. urticae* movable stages on Daytona cultivar (72.49& 67.68%), while gave lowly reduction percentages on Molokai, Giza-1and Aswan cultivars (59.72 & 54.32, 60.21& 59.13 and 65.66 & 60.78%), respectively.

3. Spraying the two pesticides; Envidor 24% SC and Endo 50% EC recorded high reduction percentages of *T. urticae* eggs on Aswan and Daytona cultivars, while recorded low reduction percentages on Giza-1 and Molokai cultivars during the two successive seasons.

4. The highest reduction percentages were recorded with Envidor and the lowest Reduction percentages was recorded with Endo during the two successive seasons.