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Research Article

Population Dynamics of *Oligonychus mangiferus* and *Aceria mangiferae* (Acari: Tetranychidae, Eriophyidae) on Two Mango Cultivars in Assiut Governorate, with an Annotated Checklist of Mango Mites in Egypt

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The mango spider mite, *Oligonychus mangiferus* (Rahman and Sapra) (Tetranychidae) and the mango bud mite, *Aceria mangiferae* Sayed (Eriophyidae) are serious pests of mango orchards in Egypt. The population dynamics of both species were studied on two mango cultivars (Zebda and Taimoor) under the natural climatic conditions of Assiut Governorate. Also, an annotated list was provided for the mite fauna inhabiting mango orchards during the present study and in previous Egyptian literature. The results showed that the population dynamics of both mite pests were affected by the ambient climatic conditions (temperature and relative humidity) and mango cultivar. The peak population of *O. mangiferus* was reported in October-November on leaves of both cultivars, while *A. mangiferae* was found regularly at almost all examined buds throughout the year. The checklist reported on 67 species belonging to 30 families and 52 genera. The predatory mites, *Eucheyletia* sp., *Lepidocheyla gracilis* Volgin (Cheyletidae) and *Hemisarcoptes coccophagus* Meyer (Hemisarcoptidae) were recorded for the first time in Egypt. Interestingly, the family Phytoseiidae represented the largest diversity of mites reported herein, with 10 species records. We anticipate that the results reported in the current study may encourage the establishment of control programs for these pests using phytoseiid mites.

Keywords: Acari; phytophagous; pest; mites; diversity; taxonomy; Trombidiformes; Eriophyoidea

INTRODUCTION

Mango, *Mangifera indica* L. (Anacardiaceae) is one of the most popular and desirable fruits in Egypt (Elsheshetawy et al., 2016). However, mango orchards are vulnerably attacked by several insect and mite pests (Reddy et al., 2018). The mango spider mite (MSM), *Oligonychus mangiferus* (Rahman and Sapra) (Trombidiformes: Tetranychidae) and the mango bud mite (MBM), *Aceria mangiferae* Sayed (Trombidiformes: Eriophyidae) are considered serious pests of mango orchards in Egypt (Jeppson et al., 1975). The MSM mostly feeds on the upper surface of mango leaves causing leaf wilting and finally leaf drop prematurely. It also attacks cotton, *Gossypium herbaceum* L.; pomegranate, *Punica granatum* L.; loquat, *Eriobotrya japonica* (Thunb.) Lindl.; peach, *Prunus persica* (L.) Batsch; grapes, *Vitis vinifera* L.; and roses, *Rosa* sp. (Migeon and Dorkeld, 2019). Several works have been conducted to study the bio-ecological features of the MSM (Zaher and Osman, 1970; Zaher and Shehata, 1972; Rai et al., 1988; Abou-Awad et al., 2012; Lin, 2013; Abu-shosha et al., 2017; Hussian et al., 2018a).

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The MBM is probably the major mite pest on mango orcahrds in Egypt. This mite attacks terminal and lateral buds and inflorescences causing bud proliferation (Jeppson et al., 1975). Moreover, it usually occurs along with the pathogenic fungus *Fusarium mangiferae* Britz, Wingfield and Marasas, that causes buds malformations (Salman et al., 1989; Gamliel-Atinsky et al., 2009). The present study aimed to estimate the population dynamics of the MSM and MBM on two mango cultivars, Zebda and Taimoor, under the natural climatic conditions of temperature and relative humidity of Assiut Governorate, Egypt. So far, there are no references compiling the mite taxa reported from mango orchards in Egypt. Therefore, an annotated list of mite species reported from mango orchards in Egypt was provided.

MATERIALS AND METHODS

Seasonal dynamics

The research work was carried out in mango orchards located in Sahel Selim (27°03'08.2"N, 31°20'11.3"E) and Elbadary (26°59'37.3"N, 31°24'56.2"E) Districts at Assiut Governorate, Egypt. The sampling localities have been known for so long of their dense mango orchards of various cultivars. Also, some fragments of date palm trees (*Pheonix dactylifera* L.) were found near the study area. Two mango cultivars (Zebda and Taimoor) were evaluated for mite incidence and population dynamics. The climate of this region is characterized by relatively hot summers, where temperature may raise above 35°C, and cold winters (Figure 1).

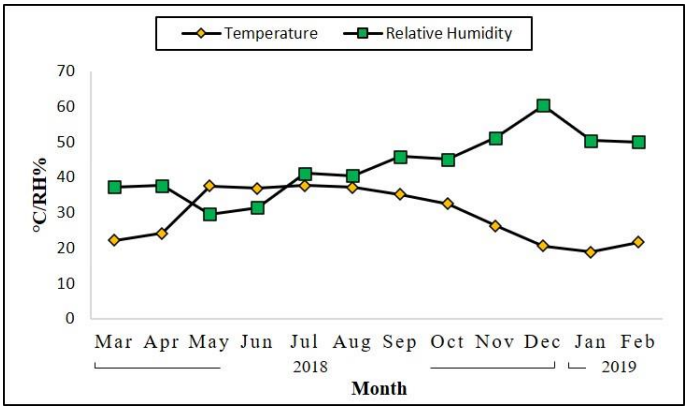

Figure 1. Meteorological data recorded during the period from March 2018 to February 2019 in Assiut Governorate, Egypt.

For mite sampling, ten pesticide-free trees of each cultivar were selected. The sampled trees were approximately 50 years old for Taimoor and 13 years old for Zebda. Samples were taken twice monthly for one year starting from March 2018, and consisted of a random collection of 20 leaves and five of each of terminal and lateral buds from the canopy of each cultivar. The leaves and buds were sorted into individual paper bags and transferred to the laboratory for mite examination. Mites on leaves and buds were counted using a stereoscopic microscope (WILD Heerbrugg M8®, Germany).

Species composition and checklist

Representative slides of different mite groups were mounted using Hoyer's medium except for the eriophyid mites were mounted in modified Berlese medium (Jeppson et al., 1975). Mite taxa were morphologically identified with the help of a phase-contrast research microscope (Olympus BH-2®, Japan) by using the following taxonomic works: (i) for Mesostigmata: Ascidae (Evans and Till, 1979), Blattisociidae (Lindquist and Moraza, 2012), Laelapidae (Joharchi and Negm, 2020), Parasitidae (Negm, 2016), Phytoseiidae (Abo-Shnaf and Moraes, 2014); (ii) for Trombidiformes: Cheyletidae (Negm and Mesbah, 2014), Cunaxidae (Skvarla et al., 2014), Stigmaeidae (Ueckermann and Meyer, 1987), Tenuipalpidae (Mesa et al., 2009), Tetranychidae (Jeppson et al., 1975), Tydeidae (Silva et al., 2014); and (iii) for other families (Hughes, 1976; Krantz and Walter, 2009). Voucher specimens were deposited in the Acari collection at the Faculty of Agriculture, Assiut University (FAAU) under voucher serial numbers. Meteorological data (temperature and relative humidity) was obtained from the online database wunderground® (The Weather Company, GA, USA). A checklist of reported species so far on mango from Egypt is provided in this study based on available literature. Species from unpublished theses were not included in the present work. Families, genera and species of mites associated with mango are presented in an alphabetical order.

RESULTS AND DISCUSSION

Seasonal dynamics of MSM and MBM on mango cultivars

The population dynamics of the MSM and MBM attacking the two mango cultivars, Zebda and Taimoor, were studied for one year under the climatic conditions (temperature and relative humidity) of Assiut Governorate (Figure 1). The MSM and MBM individuals were present throughout the year mainly on mango leaves and buds, respectively (Figures 2 and 3). They fed and developed on both cultivars.

The peak population of MSM (Figure 2) was reported during October on Taimoor when the temperature was 32.5°C and R.H. was 45%, while recorded in November on Zebda at 26.2°C and 51.2% R.H. Al-Azzazy (2005) reported that population dynamics of MSM started increasing in May. In the present study, the lowest population (Figure 2) was recorded in February and March on both cultivars at 22°C and 37% R.H. In April, few MSMs were found scattered on leaves, and by May, large populations of mites were present, especially on Taimoor.

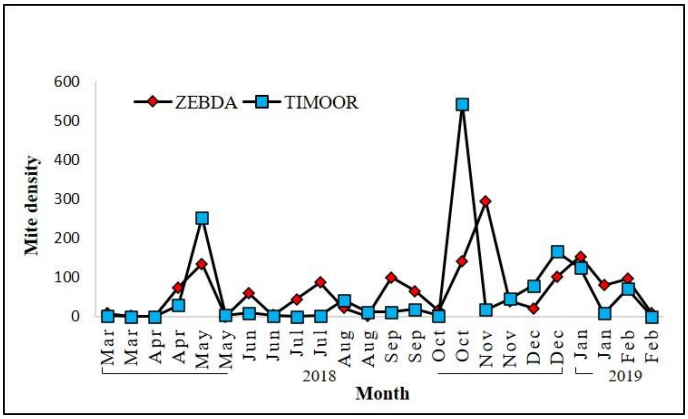

Figure 2. Population dynamics of the mango spider mite (MSM), *Oligonychus mangiferus*, on leaves of two mango cultivars (Zebda and Taimoor) in Assiut Governorate, Egypt. Sampling was done twice monthly.

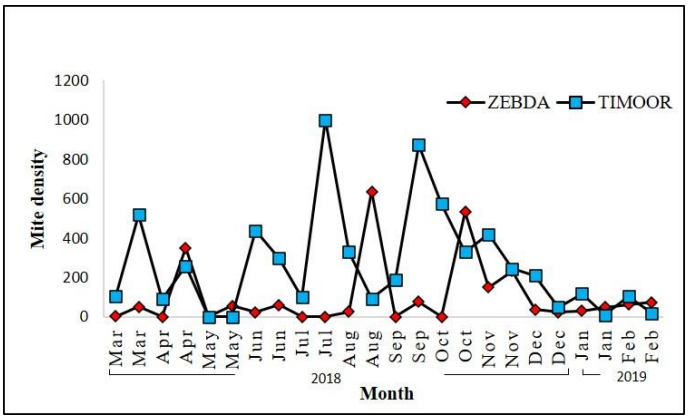

Figure 3. Population dynamics of the mango bud mite (MBM), *Aceria mangiferae*, on buds of two mango cultivars (Zebda and Taimoor) in Assiut Governorate, Egypt. Sampling was done twice monthly.

The MSM densities continued to fluctuate at lower levels through June to September and reached their peak abundance by October on Taimoor and November on Zebda. At that time, mite populations were comparatively two times higher on Taimoor than on Zebda. Mite populations started to decrease gently and reached very low numbers by February on both cultivars, but persisted on leaves in sufficient numbers (Figure 2) because of sporadic nature of leaves infestation in mango orchards and high variability within trees. During sampling, heavily infested trees were observed next to non-infested ones.

The individuals of the MBM were found regularly at almost all examined buds (terminal and lateral) and were actively living throughout the year. However, the population of MBM was low on both cultivars from late December to early March, where the temperature was as low as 22°C and the R.H. was 38%. Abou-Awad (1981) reported that MBM attacks the terminal buds of young and old trees causing bud malformation and stunting of inflorescences. In the present study, on Taimoor, the MBM numbers started to increase by mid-March, and then, fluctuated until reaching the highest peak in late July at 38°C and 40% R.H., while on Zebda, the numbers were low and the first peak appeared in August. As with MSM, the numbers of MBM were highly variable.

Species composition and checklist

The mite fauna reported from mango orchards in Egypt currently includes 30 families, 52 genera and 67 species (including unidentified genus and five species) (Table 1). Most of the taxa were reported from mango orchards by Mohamed and Nabil (2014) and Hussian et al. (2018b) at Sharkia and Ismailia Governorates, Egypt, respectively. During the current study, the potential predator *Euseius scutalis* (Mesostigmata: Phytoseiidae) was found on the leaves of Taimoor cultivar at reasonable numbers when the MSM was abundant. Furthermore, the cosmopolitan predatory mites *Cheletomimus bakeri* and *Cheletogenes ornatus* (Trombidiformes: Cheyletidae) were observed at high numbers on buds of Taimoor cultivars actively feeding upon the MBM. Evaluation of their potential as effective natural enemies of MBM should take priority in future studies. Moreover, the predatory mites *Eucheyletia* sp., *Lepidocheyla gracilis* Volgin (Cheyletidae) and *Hemisarcoptes coccophagus* Meyer (Hemisarcoptidae) are recorded for the first time in Egypt. The latter species plays an important role as a natural enemy of armored scale insects (Hemiptera: Diaspididae). Mohamed and Nabil (2014) reported a closely related predatory species *Hemisarcoptes malus* Shimer, from mango leaves at Sharkia Governorate, Egypt. A large number of *Pronematus ubiquitous* (McGregor) and *Tydeus schusteri* André and Naudo (Trombidiformes: Tydeidae) were found on leaves and buds, respectively. However, information concerning their feeding requirements is scarce. Generally, tydeid mites are known to feed on pollen, fungi and phytophagous mites (Jeppson et al., 1975). However, some studies have shown that they can play an important role in the maintenance of predatory mites serving as an alternate prey for them in the absence of spider mites (Knop and Hoy, 1983).

CONCLUSION

The population dynamics of *O. mangiferus* and *A. mangiferae* were influenced by climatic factors and mango cultivars. The high reproduction potential of these pests was mainly observed during summer and autumn seasons. Inundative releases of the associated predatory mites in the spring to delay the pest population build up might be an effective approach to reduce damage. Further research can thus shed light on the utilization of these predators for improving mango production in Egypt.

Table 1. Checklist of mite species recorded from mango orchards in the present study and available literature. *

Mite species	Habitat	Location	Reference
MESOSTIGMATA			
Ameroseiidae Evans			
Kleemania plumosus (Oudemans)	Soil	Assiut; Ismailia	(Hussian et al. 2018b; present study)
Ascidae Voigts & Oudemans			
Gamasellodes bicolor (Berlese)	Soil	Assiut	present study
Blattisociidae Garman			
Lasioseius lindquisti Nasr & Abou-Awad	Soil	Assiut	present study
Laelapidae Berlese			
Androlaelaps casalis (Berlese)	Soil	Assiut	present study
Gaeolaelaps queenslandicus (Womersley)	Soil	Assiut	present study
Ololaelaps bregetovae Shereef & Soliman	Soil	Assiut	present study
Macrochelidae Vitzthum			
Macrocheles muscadomesticae Scopoli	Soil	Assiut	present study
Melicharidae Hirschmann			
Proctolaelaps aegyptiacus Nasr	Soil	Assiut	present study
Pachylaelapidae Berlese			
Pachylaelaps near *reticulatus* (Berlese)	Soil	Assiut	present study
Parasitidae Oudemans			
Parasitus consanguineus Oudemans & Voigts	Soil	Assiut	present study
Parasitus fimetorum (Berlese)	Soil	Assiut	present study
Vulgarogamasus burchanensis (Oudemans)	Soil	Assiut	present study
Phytoseiidae Berlese			
Amblyseius enab El-Badry	Leaves	Sharkia	(Mohamed & Nabil, 2014)
Amblyseius swirskii Athias-Henriot	Leaves	Ismailia, Sharkia	(Mohamed & Nabil, 2014; Hussian et al. 2018b)
Euseius scutalis (Athias-Henriot)	Leaves	Assiut	present study
Euseius yousefi (El-Borolossy)	Leaves	Sharkia	(Mohamed & Nabil, 2014)
Neoseiulus barkeri (Hughes)	weeds	Assiut	present study
Neoseiulus cucumeris (Oudemans)	Leaves	Ismailia; Cairo	(Mohamed & Nabil, 2014; Hussian et al. 2018b)
Neoseiulus cydnodactylon (Shehata & Zaher)	Leaves	Sharkia	(Mohamed & Nabil, 2014)
Typhlodromus athiasae Porath & Swirski	Leaves	Assiut	present study
Typhlodromus mangiferus Zaher & El-Brollosy (=*T. egypticus* El-Badry)	Leaves; buds	Cairo	(Abou-Awad et al., 2011)
Typhlodromus pyri Scheuten	Leaves	Ismailia	(Hussian et al. 2018b)
Uropodidae Kramer			
unidentified genus/species	Soil	Assiut	present study
SARCOPTIFORMES			
Acaridae Leach			
Rhizoglyphus robini Claparede	Leaves	Ismailia	(Hussian et al. 2018b)
Tyrophagus putrescentiae (Schrank)	Leaves	Ismailia	(Hussian et al. 2018b)
Glycyphagidae Berlese			
Glycyphagus oryzae Attiah	Leaves	Ismailia	(Hussian et al. 2018b)
Haplozetidae Grandjean			
Xylobates souchnaiensis Abdel-Hamid	Leaves	Sharkia	(Mohamed & Nabil, 2014)
Hemisarcoptidae Oudemans			
Hemisarcoptes coccophagus Meyer**	Leaves	Assiut	present study
Hemisarcoptes malus Shimer	Leaves	Sharkia	(Mohamed & Nabil, 2014)
Oppiidae Grandjean			
Oppia sticta Popp	Leaves	Ismailia	(Hussian et al. 2018b)
Oribatulidae Thor			
Zygoribatula sayedi El-Badry & Nasr	Leaves	Ismailia	(Hussian et al. 2018b)
TROMBIDIFORMES			
Camerobiidae Southcott			

Table 1 Cont'd. Checklist of mite species recorded from mango orchards in the present study and available literature. *

Mite species	Habitat	Location	Reference
Neophyllobius gonzali Zaher & Gomaa	Leaves	Ismailia	(Hussian et al. 2018b)
Neophyllobius mangiferus Zaher & Gomaa	Leaves	Ismailia	(Hussian et al. 2018b)
Cheyletidae Leach			
Cheletogenes ornatus (Canestrini & Fanzago)	Leaves; buds	Assiut	(Negm & Mesbah, 2014; present study)
Cheletomimus bakeri (Ehara)	Leaves; buds	Assiut	present study
Cheyletus attiahi Yousef & Issa	Soil	Assiut	present study
Eucheyletia sp.**	Leaves	Assiut	present study
Lepidocheyla gracilis Volgin**	Leaves	Assiut	present study
Cunaxidae Thor			
Cunaxa capreolus (Berlese)	Leaves; soil	Assiut; Sharkia	(Mohamed & Nabil, 2014; present study)
Cunaxa setirostris (Hermann)	Leaves	Ismailia	(Hussian et al. 2018b)
Neocunaxoides andrei (Baker & Hoffmann)	Soil	Assiut	present study
Neocunaxoides ovatus Zhang & Ji	Soil	Assiut	present study
Ereynetidae Oudemans			
Ereynetes sp.	Soil	Assiut	present study
Eriophyidae Nalepa			
Aceria mangifera Sayed	Buds; inflorescences; leaves	Ismailia; Cairo; Assiut	(Sayed, 1946; Abou-Awad, 1981; Hussian et al. 2018b; present study)
Cisaberoptus kenyae Keifer	Leaves	Cairo	(Zaher, 1984; Abou-Awad et al., 2010)
Metaculus mangiferae (Attiah)	Leaves; buds; inflorescences	Cairo	(Attiah, 1955; Abou-Awad, 1980)
Tegonotus mangiferae (Keifer)	Leaves	Cairo	(Zaher, 1984)
Vasates aegyptiacus Abou-Awad	Buds	Cairo	(Abou-Awad, 1980)
Eupalopsellidae Willmann			
Saniosulus nudus Smmere	Leaves	Sharkia	(Mohamed & Nabil, 2014)
Eupodidae Koch			
Eupodes momeni Abou-Awad	Leaves	Ismailia	(Hussian et al. 2018b)
Pygmephoridae Cross			
Pediculaster zaheri Sevastianov & Abo-Korah	Soil	Assiut	present study
Raphignathidae Kramer			
Raphignathus gracilis Rack	Leaves	Sharkia	(Mohamed & Nabil, 2014)
Stigmaeidae Oudemans			
Agistemus exsertus Gonzalez-Rodriguez	Leaves	Assiut; Sharkia; Ismailia	(Mohamed & Nabil, 2014; Hussian et al. 2018b; present study)
Apostigmaeus sp.	Leaves	Ismailia	(Hussian et al. 2018b)
Tarsonemidae Kramer			
Polyphagotarsonemus latus (Banks)	Leaves; buds	Assiut	present study
Steneotarsonemus sayedi Zaher & Kandeel	Leaves	Sharkia	(Mohamed & Nabil, 2014)
Tenuipalpidae Berlese			
Brevipalpus obovatus Donnadieu	Leaves	Sharkia	(Mohamed & Nabil, 2014)
Brevipalpus sp.	Leaves	Assiut	present study
Phyllotetranychus aegyptiacus Sayed***	Leaves	Assiut	present study
Tetranychidae Donnadieu			
Oligonychus mangiferus (Rahman & Sapra)	Leaves	Sharkia; Ismailia; Assiut	(Abou-Awad et al. 2012; Mohamed & Nabil, 2014; Hussian et al. 2018a; present study)
Tetranychus urticae Koch	Leaves	Ismailia	(Hussian et al. 2018b)
Tydeidae Kramer			
Paralorryia aegyptiaca Rasmy & Elbagoury	Leaves	Assiut	present study
Pronematus ubiquitous (McGregor)	Leaves	Sharkia	(Mohamed & Nabil, 2014)

Table 1 Cont'd. Checklist of mite species recorded from mango orchards in the present study and available literature. *

Mite species	Habitat	Location	Reference
Tydeus californicus (Banks)	Leaves	Assiut; Ismailia	(Hussian et al. 2018b; present study)
Tydeus kochi Oudemans	Leaves	Sharkia	(Mohamed & Nabil, 2014)
Tydeus oregonensis Baker	Leaves	Sharkia	(Mohamed & Nabil, 2014)
Tydeus schusteri André & Naudo	Buds	Assiut	present study

* Species were listed by their updated and commonly accepted scientific names, without revising species synonymy or validity.
** New record to Egypt
*** Only one individual, most probably found accidentally.

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