Mycetoglyphus qassimi and Tyrophagus putrescentiae, Two Acarid Mites Recovered from Palm Fields, Feeding on Root-Knot Nematode Meloidogyne javanica in Al-Qassim Area, Saudi Arabia

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Abstract. Two acarid mites Mycetoglyphus qassimi Fouly and Al-Rehiayani, and Tyrophagus putrescentiae (Schrank) recovered from date palm field in Al-Qassim area, Saudi Arabia were tested against the root-knot nematode Meloidogyne javanica under lab conditions. Also, life history of both mite species was studied under controlled conditions of 27ºC and 70% RH. The two mites are considered omnivorous where they fed on three different food sources tested, egg masses M. javanica, date palm pollen Pheonex dactylifera L., and fungal propagules of Aspergillus niger. Acarid mites successfully completed their life span feeding on all types of food. Feeding on egg masses of M. javanica accelerated the development. Some hypopal stages were observed in rearing units of M. qassimi. Also, males of both species reached adulthood before females where they had a shorter longevity than females. A diet of M. javanica eggs was the most suitable food and supported the highest net reproductive rate $R_0$ (fecundity) for M. qassimi while pollen grains were the best for T. putrescentiae. The intrinsic rate of natural increase ($r^m$) was at its highest level when M. qassimi and T. putrescentiae were provided with egg masses of nematode and followed by pollen and fungi. Similar trends were observed with the finite rates of increase ($e^{rm}$). Results showed that Mycetoglyphus mite could be a good biological control agent against egg masses of M. javanica.

Keywords: Mycetoglyphus qassimi, Tyrophagus putrescentiae, Meloidogyne javanica, date palm pollen, fungi, biology, life table parameters.
Introduction

Root-knot nematode *Meloidogyne* species are widespread and considered to be one of the most destructive and important plant pathogen group causing serious losses to most agricultural crops all over the world (Netscher and Sikora, 1990). They are widespread in Al-Qassim area, Saudi Arabia (Al-Rehiayani and Farahat, 2004). Root-knot nematodes are often managed in Al-Qassim with chemical nematocides causing a considerable contamination to the agro-ecosystems. Increased concern of human health, farm animals and soil fauna have promoted researchers at the area to find alternative methods of nematode control (Al-Rehiayani, 2001 and 2005). There is a renewed interest in the use of biological control agents and nematode natural enemies as management strategies for nematode control (Al-Rehiayani, 2004). Among these natural enemies are mites belonging to Parasitiforme and Acariforme groups (Walter, 1988), although little is still known about the habits of many species that form together the belowground food web (Mankau and Imbriani, 1978; Mankau, 1980; Fouly, 1997; Mostafa, et al., 1997 and Al-Rehiayani and Fouly, 2005). Few trials had demonstrated the ability of some soil mites such as acarid mites to reduce plant parasitic nematode populations. Acarid mites were considered as omnivorous where they can feed on a variety of algae, fungi as well as nematodes (Walter, 1988). Root-knot nematode eggs are likely favorable stages to mite (Al-Rehiayani and Fouly, 2005), even though, some species of the genera *Tyrophagus*, *Caloglyphus*, and *Tyroglyphus* were observed feeding on different stages of plant parasitic nematodes (Bhattacharyya, 1962; Walter and Kaplan, 1990; Walter, et al., 1993 and Walia and Mathur, 1995).

Accordingly, a preliminary survey study for the mite fauna in Al-Qassim area proved the presence of some mite species belonging to gamasid and acarid mites which inhabit the plant rizosphere (Al-Rehiayani and Fouly, 2005). Therefore, the present investigation was initiated to determine some biological aspects of the two acarid mite species *Mycetoglyphus qassimi* and *Tyrophagus putrescentiae* (Shrank) for the first time in Saudi Arabia. The mites effectiveness in reducing some of the co-existence harmful organisms such as root knot nematode *M. javanica* (Treub), as local biological control agents, in comparison with their feeding on the fungus *Aspergillus niger* and date palm pollen grains *Pheonex dactylifera* L. was also evaluated. Moreover, life table parameters of both acarid mite species were determined and evaluated when they were provided with different food sources.

Materials and Methods

**Cultures of Acarid Mite Species in Laboratory**

Laboratory cultures of both acarid mites *M. qassimi* and *T. putrescentiae* were originated from soil samples including date palm trees rizosphere at
Al Qassim University Experimental Station, Al Qassim, Saudi Arabia in 2005. The collected mite individuals were maintained on the root system of tomato plants containing egg masses of root-knot nematode *M. javanica* as a food source in plastic rearing units (10 cm in diameter).

**Rearing of Acarid Mites in Laboratory for Biological Studies**

Approximately 25 of newly deposited eggs of *M. qassimi* and *T. putrescentiae* have been singly placed in smaller rearing units (2 cm in diameter), where immature stages were provided with one of the food types, egg masses of root-knot nematode *M. javanica*, the fungus *A. niger*, date palm pollen grains *P. dactylifera* during their entire life span. All rearing units were kept in an incubator at 27 ± 1 ºC and 70% ± 5 RH. In all cases, incubation period, duration of developmental stages (in days), number of surviving mite individuals and egg production were recorded daily. Data were statistically analyzed using Co-stat Program (Version 2, Chorot Software, 1986). Life table parameters of both acarid mites *M. qassimi* *T. putrescentiae* which were fed on three different foods, were calculated (Birch, 1948) and by using the Basic Computer Program (Abou Setta, *et al.*, 1986) where:

- L = number of female alive
- x = actual female age (in days)
- Mx = female progeny / female (mothers) /day x (specific fecundity rate)
- Lx = rate of survival at day x
- Ro = the net reproductive rate (∑Lx Mx)
- T = the mean generation time (∑Lx Mx . x)
- rm = the intrinsic rate of natural increase
- e^rm = the finite rate of increase

**Results**

The incubation period of the newly deposited eggs ranged from 3.15 to 4.07 days for *M. qassimi* female eggs and from 3.08 to 4.18 days for males, while it ranged from 4.15 to 4.36 days for female eggs of *T. putrescentiae* and from 3.01 to 3.44 days for males at 27°C and 70%RH. Successful development from larva to adult in both acarid mite species was observed when they were supplied with fungi, date palm pollen and egg masses of root-knot nematode as foods. Both sexes of *M. qassimi* and *T. putrescentiae* passed through three developmental stages (larva, protonymph and tritonymph) before reaching adulthood. Hypopal stages were rarely found.. All immature stages except hypopus were seen feeding on all kinds of food. Concerning feeding behavior on egg masses of root-
knot nematode, mite individuals from all stages were observed penetrating the gelatinous matrix of egg mass by their rostrum and chelicerae and finally immersed the whole gnathosomal region inside the egg mass and began to devour its contents (Fig. 1).

Fig. 1. Immature and adult male and female individuals of *M. qassimi* feeding on egg masses of root-knot nematode.

The newly hatched larvae of *M. qassimi* were shiny white in color with three pair of legs and they moved very slowly but they had the ability to feed on all kinds of food sources. No significant differences of the effect of food substance on the duration of larvae were noticed when larvae of *M. qassimi* were provided with egg masses of *M. javanica* and date palm pollen grains but both foods significantly differed with fungi. The same trend was also observed with the first and second deutonymph. In general, total immature stages of *M. qassimi* lasted 9.61, 11.01 and 15.16 days and lasted 8.41, 9.37 and 11.36 days for female and male immatures which were provided with egg masses of *M. javanica*, date pollen and fungi as food sources, respectively. Therefore, it was noticed that the food source had a significant effect of the total period of developmental stages of *M. qassimi* (P<0.05) (Table 1).

It was noticed that feeding on root-knot nematode *M. javanica* shortened the development of the immature stages of *M. qassimi* followed by the feeding on date palm pollen while fungi occupied the last rank. Males developed faster than females and that is considered to be advantageous for successful mating. Mating was observed where the copulation lasted for a long time in the region of male genitalia and female bursa copulatrix. Generally, it was observed that mating was necessary for egg production where mating was noticed in all rearing units. Average adult female of *M. qassimi* needed 4.04, 6.25 and 7.08 days
Table 1. Developmental time of different stages and adult males and females (days) of *Mycetoglyphus qassimi* fed on different food sources and kept at 26°C and 70% RH.

<table>
<thead>
<tr>
<th>Food source</th>
<th>Sex</th>
<th>No.</th>
<th>Incubation period</th>
<th>Developmental period</th>
<th>Adults</th>
<th>Life span</th>
<th>Sex ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L</td>
<td>N</td>
<td>N</td>
<td>T</td>
</tr>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><em>M. javanica</em> (egg masses)</td>
<td>♀</td>
<td>18</td>
<td>4.07a  ± 0.70</td>
<td>2.56a</td>
<td>3.42a</td>
<td>3.63b</td>
<td>9.61a</td>
</tr>
<tr>
<td></td>
<td>♂</td>
<td>14</td>
<td>3.08a  ± 0.64</td>
<td>2.58a</td>
<td>2.75a</td>
<td>3.08a</td>
<td>8.41a</td>
</tr>
<tr>
<td>Date pollen</td>
<td>♀</td>
<td>16</td>
<td>3.15a  ± 0.77</td>
<td>3.30a</td>
<td>3.62a</td>
<td>4.15a</td>
<td>11.01a</td>
</tr>
<tr>
<td></td>
<td>♂</td>
<td>15</td>
<td>3.36a  ± 0.48</td>
<td>2.64a</td>
<td>3.09a</td>
<td>3.64a</td>
<td>0.37b</td>
</tr>
<tr>
<td>Fungi</td>
<td>♀</td>
<td>17</td>
<td>3.58b  ± 0.49</td>
<td>4.75b</td>
<td>5.08b</td>
<td>5.33b</td>
<td>15.16d</td>
</tr>
<tr>
<td></td>
<td>♂</td>
<td>14</td>
<td>4.18b  ± 0.72</td>
<td>3.63b</td>
<td>3.91b</td>
<td>3.82a</td>
<td>11.36d</td>
</tr>
</tbody>
</table>

L = Larva, N₁ = Protonymph, N₃ = Tritonymph and T = Total immature stages. Means within each column (either for males or females) having the same letter aren't significantly different (L.S.D.) (P< 0.05) (Costat program, version 2).

before laying eggs and it continued laying eggs for a period of 17.29, 15.46 and 12.50 days when it was provided with the aforementioned kinds of food, respectively. That means, egg masses of root-knot nematode *M. javanica* were not only the most suitable food source for *M. qassimi* development but they caused the greatest egg deposition. It was noticed that mite females laid their eggs inside the egg masses and also outside on the surrounding root system close to nematode galls (Fig. 2).

Fig. 2. Eggs of Acarid mites deposited on egg masses of root-knot nematode *M. javanica*.
It was noticed that *T. putrescentiae* had a similar trend of *M. qassimi*, although, food types had a limited effect on the development of larvae and nymphs, there were significant differences for the effects of food substances on the total immature development. Also, there were significant differences between the effect of egg masses of root-knot nematode *M. javanica* and date palm pollen where total development of female immatures averaged 11.27, 17.83 and 20.25 days when they were fed on egg masses of *M. javanica*, pollen and fungi, respectively. Similarly, a diet of egg masses of root-knot nematode significantly shortened the preoviposition period and gave the Tyrophagid mite females the longest oviposition period. Female took an average of 3.5, 5.67 and 7.33 days in the pre-oviposition period and an average of 14.83, 10.84 and 9.50 days for laying eggs (Table 2). In all cases, males lived for a shorter time than females.

### Table 2. Developmental time of different stages and adult males and females (days) of *Tyrophagus putrescentiae* fed on different food sources and kept at 26ºC and 70% RH.

<table>
<thead>
<tr>
<th>Food source</th>
<th>Sex</th>
<th>No.</th>
<th>Incubation period</th>
<th>Developmental period</th>
<th>Adults</th>
<th>Life span</th>
<th>Sex ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L</td>
<td>N₁</td>
<td>N₃</td>
<td>T</td>
</tr>
<tr>
<td><em>M. javanica</em> (egg masses)</td>
<td>♀️</td>
<td>21</td>
<td>4.36 ± 0.48</td>
<td>3.91 ± 0.08</td>
<td>3.86 ± 0.52</td>
<td>3.88 ± 0.53</td>
<td>11.27 ± 1.02</td>
</tr>
<tr>
<td></td>
<td>♂️</td>
<td>16</td>
<td>3.44 ± 0.48</td>
<td>3.44 ± 0.83</td>
<td>4.22 ± 0.41</td>
<td>4.27 ± 0.44</td>
<td>11.82 ± 0.73</td>
</tr>
<tr>
<td><em>Date pollen</em></td>
<td>♀️</td>
<td>19</td>
<td>4.15 ± 0.53</td>
<td>5.60 ± 0.47</td>
<td>5.90 ± 0.64</td>
<td>6.33 ± 0.62</td>
<td>17.83 ± 1.19</td>
</tr>
<tr>
<td></td>
<td>♂️</td>
<td>15</td>
<td>3.01 ± 0.63</td>
<td>3.20 ± 0.71</td>
<td>5.10 ± 0.70</td>
<td>6.20 ± 1.02</td>
<td>14.50 ± 1.02</td>
</tr>
<tr>
<td><em>Fungi</em></td>
<td>♀️</td>
<td>20</td>
<td>4.27 ± 0.54</td>
<td>6.00 ± 0.71</td>
<td>6.83 ± 0.69</td>
<td>7.42 ± 1.01</td>
<td>20.25 ± 1.02</td>
</tr>
<tr>
<td></td>
<td>♂️</td>
<td>15</td>
<td>3.40 ± 0.49</td>
<td>4.80 ± 0.87</td>
<td>5.80 ± 0.40</td>
<td>6.40 ± 1.03</td>
<td>17.00 ± 1.03</td>
</tr>
</tbody>
</table>

L = Larva, N₁ = Protonymph, N₃ = Tritonymph and T = Total immature stages.
Means within each column (either for males or females) having the same letter aren't significantly different (L.S.D.) (P < 0.05) (Costat program, version 2).

The percentage of daughter females in the total population averaged 53%; 54% and 52% for *M. qassimi* and 57%; 54% and 56% for *T. putrescentiae* when they were fed on egg masses of *M. javanica*, date pollen and fungi, respectively. These values were considered in the calculation of life table parameters. The mean generation time (T) is highly affected by food sources where it averaged...
Discussion

Egg masses of *M. javanica* highly accelerated the development of *M. qassimi* more than did other food sources. These findings agree with those previously obtained by Al Rehiayani and Fouly (2005) who found that feeding on egg masses of both plant parasitic nematodes *M. javanica* and *Tylenchulus semi-
Fig. 3. Age specific fecundity (Mx) and survival rate (Lx) of *Mycetglyphus qassimi* on three food sources at 27°C.
Fig. 4. Age specific fecundity (Mx) and survival rate (Lx) of *Tyrophagus putrescentiae* on three food sources at 27°C.
penetrans (Cobb) caused the fastest development of the gamasid predatory mite *Cosmolaelaps simplex* (Berlese) in comparison with the acrid prey *Caloglyphus redriguezi* Samsinak. On the contrary, Fouly (1997) found that feeding on acrid mite was better and caused a faster development for *Laseiosius dentatus* (Fox) than did egg masses of plant parasitic nematode *M. javanica*. That may be due to the suitability of prey types in enhancing the predator development that mainly depends on prey and predator species. Moreover, Stirling (1991) noticed that *Caloglyphus berlesei* successfully developed and multiplied feeding on egg masses of *M. javanica* while *Tyrophagus similis* was often observed on females of cyst nematode *Heterodera avenae*. Walia (1992) and Walia and Mathur, (1995) found that *T. putrescentiae* showed a degree of ability to feed and survive on *Apheelenchoides composticola*.

Considering the biological characteristics of *M. qassimi* and *T. putrescentiae* may indicate the possibility of their potential role as biological control agents against root-knot nematode *M. javanica* if they were introduced to the infected plants at the right time. Also, the relatively short life cycle and their high reproductive rate, as noticed from life table parameters, allowed the mite population to increase as nematodes increased. Thus, with such feeding habit where the mites attacked and voraciously fed on egg masses may indicate that mites could be useful in suppressing nematode population. Also, the ability of both acarid mite (as omnivorous) to utilize alternative food sources (fungi, pollen) as well as nematodes are other advantageous characteristics as their great mobility and spatial range (Imbriani and Mankau, 1983 and Fouly, 1997). Also, *M. qassimi* and *T. putrescentiae* have a chelate dentate chelicerae may be considered omnivorous that can facultatively feed on different kinds of food. However, root-knot nematode, which occurs near the soil surface surrounding root-system may be vulnerable to the mites (Al Rehiayani and Fouly, 2005).

On the other hand, it is accepted that the most effective biological control agents are those that don’t initially cohabit with the prey. Since predaceous mites are commonly living in most soils and don’t seem to be effectively regulating plant parasitic nematodes. The mite potential for exploitation as applied biological control agent in suppressing nematode population may be limited (Walter, 1988 and Mostafa, *et al.*, 1997). From our point of view, the key to increase mite efficiency against some plant parasitic nematodes such as root-knot nematodes may be by the modification of the environment surrounding plant roots, so that soil physical characteristics may provide suitable conditions for micro-arthropod activity. Therefore, the tested acarid mites *M. qassimi* and *T. putrescentiae* can be utilized as biological control agents against root-knot nematodes *M. javanica*. Future work is needed to explore factors favoring substantial populations of nematode-destroying mites.
Acknowledgement

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References


Costat Program (1986) Version 2, Chorot Software.


مسيتوجليفس قاصصماي و تيروفاجس بترسينشيا - نوعان من الحلم الأكاريدي في مزارع نخيل التمر و يتغذيان على نيماتودا تعقد الجذور ميلودوجين جافانياكا في القصيم - المملكة العربية السعودية

سليمان محمد الزياني و أحمد حسن نولي
كلية الزراعة والطب البيطري - جامعة القصيم
بريدة - المملكة العربية السعودية

المستخلص. تم حصر النوعين مسيتوجليفس قاصصماي و تيروفاجس بترسينشيا - وهما من مجموعة الحلم الأكاريدي عند الثغور التنفسية - في منطقة المجمع الجذري لأشجار نخيل التمر في منطقة القصيم. تم دراسة تاريخ حياة كلا النوعين بالتفصيل تحت ظروف العمل (٢٧٤ درجة مئوية ورطوبة ٧٠٪) وذلك بتغذيةهما على ثلاثة أنواع من الغذاء، هي حبوب لقاح نخيل التمر والفطر أسبيريلنوس نجر، وكتل بيض نيماتودا تعقد الجذور ميلودوجين جافانياكا (والتي تعتبر من أهم مسببات الأمراض التي تسبب نباتات الخضروات وكافة المحاصيل الزراعية الهامة) وذلك لأول مرة في منطقة القصيم.

نُهج نوعاً جديداً في إكمال حياتهما بالغذاء على أنواع الغذاء الثلاثة، حيث لوحظ أن التغذية على كتل بيض نيماتودا تعقد الجذور أدت إلى تشتيت وإسريع النمو. كما لوحظ وجود بعض أطوار مرة دورة جذور (الهبيوس) في النوع مسيتوجليفس قاصصماي، وأن الأطوار غير الكاملة لذكور كلا النوعين وصلت إلى الظهر البالغ قبل إتمامها. كما أن الذكور البالغة عاشت لفترة أقصر من الإناث. ولاحظت طريقة تغذية نوعي الحلم الأكاريدي على كتل بيض النيماتودا حيث تقترب كل الأطوار الكاملة وغير الكاملة من كتلة البيض، وبدأ في تحرير ثم غور الزوايد الملقحة في الطب العلوي المغلف لكتلة البيض وتستمر في دفع مقدمة أجسامها للداخل حتى تصبح منطقة الرأس الكاذب (الخانوسوما) بكلامها داخل كتلة بيض النيماتودا وبدأ في امتصاص محتواها.
كانت النسبة الجنسية للإناث في النوع ميسيتوجيليس قاصيميا هي 53٪، 54٪، بينما كانت 75٪، 54٪، 75٪ للنوع تيروفاجس بترسينيشيا عند التغذية على بذور النيماتودا وحبوب لقاح التحيل والفطر على الترتيب. تم إدراج واستخدام النسبة الجنسية في حساب جداول حياة كلا النوعين. تأثرت مدة متوسط الجيل (T) معنويًا بنوع الغذاء حيث كانت مدة الجيل هي الأقصر عند التغذية على كتل بذور النيماتودا، تلاها التغذية على حليب اللقاح ثم الفطر. كما أوضحت النتائج بصورة واضحة أن التغذية على كتل بذور النيماتودا تعقد الجذور كانت هي الأنبس حيث أظهرت أعلى معدلات الخصوبة ووضع البذور (R0) في النوع ميسيتوجيليس قاصيميا، بينما كانت هذه الأفضلية حبوب لقاح التحيل بالنسبة للنوع تيروفاجس بترسينيشيا كما هو موضح في جداول حياة كلا النوعين. كما وصل معدل تضاعف النوع (mT) إلى أعلى معدلاته في النوعين عند التغذية على بذور النيماتودا تعقد الجذور. وكانت النتيجة بالمثل بالنسبة ل معدل التزايد النوعي اليومي (mT). أوضحت نتائج التربة وجداول الحياة أن النوع ميسيتوجيليس قاصيميا يمكن أن يلعب دورًا هامًا ك العدو حيوي في برامج مكافحة جيد ضد النيماتودا تعقد الجذور وخاصة في البيوت محمية.