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EFFECTS OF THE ACARID MITE *Mycetoglyphus qassimi* (Acari:Acaridae) AND CHICKEN MANURE ON THE ROOT-KNOT NEMATODE *Meloidogyne javanica* REPRODUCING ON TOMATO IN AL-QASSIM, SAUDI ARABIA

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Abstract: The effect of the acarid mite, *Mycetoglyphus qassimi* (Acari: Acaridae) and chicken manure against the root-knot nematode, *Meloidogyne javanica* on tomato were evaluated under greenhouse conditions in Al Qassim, Saudi Arabia. The control of the root-knot nematode by using the acaried mite and chicken manure was compared with the effect of the nematicide Oxamyl (Vydate, 24%). Chicken manure highly accelerated the growth of both root and shoot systems of tomato in addition to suppressing root galls and egg masses of *M. javanica*. Chicken manure supported the acarid mite vitality and feeding capacity on *M. javanica* as compared with control treatments with nematode only. However, vydate application gave the highest effect in reducing both root galls and egg masses on root system and followed by mite treatments. The reduction percentages in numbers of nematode galls averaged 79.69% when tomato plants grown in chicken manure amended soil. This value was clearly decreased to 65,9% in soil that received mite individuals. Also, the effect of Vydate application was higher than mite introduction on the total number of egg masses of *M. javanica* especially in plants grown in chicken manure soil. The effect of mite application on *M. javanica* was enhanced by combination with chicken manure amendment.

Key words: Predaceous mite *Mycetoglyphus qassimi*, root-knot nematode, *Meloidogyne javanica*, date palm trees, *Phoenix dactylifera*, biological control, chicken manure.

Introduction

Plant parasitic nematodes are widespread and cause serious losses to most agricultural crops, vegetables and fruits (Netscher and Sikora 1990). Root-knot nematodes, . are serious pest problem in Al-Qassim area, Saudi Arabia (Al-Rehiayani and Farahat, 2004). Because of wide host range of root-knot nematodes, Saudi growers especially in Al-Qassim area have focused most of their effort on chemical nematicides for their quick action, while other control tactics are unfortunately limited so far (Al-Rehiayani, 2005; Al-Rehiayani, 2001). Therefore, extensive application of nematicides may contaminate agro-ecosystems. Natural antagonistic of nematodes and biocontrol agents may provide an alternative to the use of pesticides for nematode management (Stirling, 1991). It is well known that the Acari exhibit various associations with soil fauna especially nematodes (Walter, 1988; Al-Rehiayani and Fouly, 2005). Since beneficial soil mites especially predatory species must be conserved in the field to promote a more stabilized pest and natural balance (Imbriani and Mankau, 1983). Until now, the potential of using the predaceous mites as biological control agents in controlling plant parasitic nematodes have rarely been studied (Al-Rehiayani and Fouly, 2005 and 2006). Accordingly, several trials had demonstrated the ability of some soil mites to reduce nematode populations. Acarid mites belonging to the suborder Acaridida (Astigmata) represent an important component of the belowground food web. Previous researches proved that root-knot nematodes are likely favorable food to acarid mites such as some species of the genera Tyrophagus, Caloglyphus and Tyroglyphus (Walter and Kaplan, 1990; Walter, et al, 1993). It was noticed that T. putrescentiae (Schrank) fed voraciously on the vermiform stages and free eggs of *M. javanica* (Walia and Mathur, 1995). Also, both acarid mite species *Mycetoglyphus qassimi* , Al-Rehiayani Fouly and T. putrescentiae succeeded to complete their life span feeding only on egg masses of *M. javanica*(Al-Rehiayani and Fouly, 2006). On the other hand, it is known that some of organic amendments have nematicidal activity against plant parasitic nematodes and the application of some organic materials such as chicken manure may be sufficient to keep nematode population below the economic threshold level (Errico and Di Maio, 1980). Moreover, Maraeg (1984) found that cattle manure and pigeon dung reduced the population of M. javanica and significantly increased plant growth as well. The value of using chicken manure as fertilizer and to suppress phytonematode populations and other soil pathogens has been previously discussed by Rodriguez-Kabana (1986), Rodriguez-Kabana et al,(1987), Stirling (1991), Al-Rehiayani (2001) and Elmeliegi and Al-Rehiayani (2004). Therefore, the present investigation was conducted to evaluate the effect of the acarid mite

M. qassimi or the nematicide Oxamyl in combination with chicken manure on the root-knot nematode, *M. javanica* infecting tomato.

Materials and Methods

Nematode Culture

A pure culture of root-knot nematode, *M. javanica* was obtained on tomato plants grown in a greenhouse at the Agricultural Experimental Station, College of Agriculture and Veterinary Medicine, Qassim University, Saudi Arabia.

Rearing of the Acarid Mite, M. qassimi under Laboratory conditions

Laboratory culture of the acarid mite M. qassimi was originated from soil samples collected from date palm fields *Phoenex dactylifera* L. Individuals of *M. qassimi* were subsequently collected by using the modified Tullgern's funnels (Krantz, 1978) and maintained on egg masses of root-knot nematode, *M. javanica* as a food source in rearing units which was previously described by Fouly (1997).

Chemicals

Oxamyl {N, N - dimethyl - 2 - methylcarbamoyloxyimino - 2- (methylthio) acetamide} (Vydate 24%) was sprayed to the shoot system.

Greenhouse Experiments

Four weeks old tomato seedlings were transplanted in plastic pots (25cm in diameter) containing sandy loam soil half of which was previously fertilized with 50g chicken manure for each pot, while the other half was left un-fertilized. Tomato seedlings were subsequently received the following treatments: The first group was inoculated with 5000 eggs of nematode/pot (**N**). In the second group, each pot was inoculated by the same number of nematode and 200 mite individuals (N+M). The third group was inoculated by nematodes and treated with the nematicide Vydate (24%) (N+V). The fourth group was left without treatments and used as a check (CK). The treatments were arranged in a randomized complete design and each was replicated four times. Sixty days after nematode inoculation, tomato plants were carefully taken off where data dealing with fresh root and shoot weight were recorded. Roots were carefully washed and left free of soil, where total number of galls and egg masses per root was recorded. In general, numbers of galls and egg masses per root system were represented by the mean number of galls or egg masses per 1g of root multiplied by the total root weight, where each replicate was subsequently divided into three subsamples for statistical analysis purpose. Soil samples of 250g each were also subjected for mite extraction by the aid of the modified Tullgern's funnels, where the mite reproduction index (Pf/Pi) = final mite population (Pf) / initial population (Pi) was calculated.

Data Analysis

The data were subjected to analysis of variance ($P<0.05$) and mean differences for each variable were compared using Duncan's multiple-range test (Duncan, 1955). Values for number of galls and egg masses per root system were log transformed before being analyzed and illustrated. Moreover, polynomial regression analysis was performed by the method of SAS (SAS Institute, Inc., 1996) to evaluate the relationship between the influence of each treatment (N, N+M, N+V and CK and chicken manure (CM) on root weight, shoot weight, number of galls and number of egg masses of nematodes per root system.

Results and Discussion

The highest root weight was recorded when N+V (nematode + Vydate) was used followed by untreated plants CK and then N+M (nematode + mites) and N (nematode) alone. Table (1) clearly showed that the differences between N and N+M on root weight were not significant while all other differences between treatments are significant. Similarly, amendment of soil with chicken manure has a better effect on root system where root weight averaged 5.35g as compared with 2.93g in un-fertilized soil. Similar trend was observed concerning the shoot weight where the differences between the effect of different treatments were also significant (Table 1). Chicken manure significantly enhanced shoot weight (8.14g) as compared with treatments in the absence of manure (5.07g). Data also showed that the interaction between treatments in either chicken manure amended or un-amended soils was significant (P<0.001) as shown in Table (1).

Table(1): Effects of *Meloidogyne javanica* on tomato planted in chicken manure amended or un-amended soils and subjected to the acarid mite Mycetoglyphus qassimi and nematicide Vydate under greenhouse conditions.

Independent factor	Root weight (gm)	Shoot weight (gm)
Treatments (T)		
Nematode (N)	3.91 c	6.24 c
Nematode + mites (N+M)	3.92 c	6.96 b
Nematode + Vydate (N+V)	4.46 a	5.72 d
Control (CK)	4.27 b	7.49 a
± SE	0.033	0.080
Chicken manure (CM)		
Amended soil	5.35 a	8.14 a
Un-amended soil	2.93 b	5.07 b
± SE	0.023	0.056
Interactions		
T x CM	* * *	* * *
RSD	0.133	0.322

*** = P< 0.001 RSD = residual stander deviation

Means followed by the same letters within a column are not significantly different (P<0.05)

There were significant differences between the effect of all kinds of treatments on numbers of galls and egg masses (P<0.001). The lowest rate of root galls was achieved by nematicide application and followed by mite treatment. However, the acarid mite, *M. qassimi* significantly suppressed nematode population that reflected in reducing number of root galls and egg masses of *M. javanica* (Table 2). These results indicated that acarid mite preferred chicken manure amended soil and un-compacted sandy loam soil which may provide enough space for mite individuals to move and do different vital activities. Similar results were obtained by Stirling (1991) who noticed that the acarid mite, *Caloglyphus berlesei* successfully developed and multiplied on egg masses of *M. javanica* in pots covered with sand. Sharma (1979) also found that micro-arthropods can have significant effects in such environments, as numbers of *Tylenchorhynchus dubius* were reduced by about 60% in pots containing sandy loam soil and three different mite species as compared with pots without mites.

Table(2): Effect of the acarid mite, *Mycetoglyphus qassimi* and nematicide Vydate on root galls and egg masses of *Meloidogyne javanica* infecting tomato planted in chicken amended or un-amended soils under greenhouse conditions.

Independent factor	Galls/g root	Egg masses/g root
Treatments (T)		
Nematode (N)	3.49 a	2.86 a
Nematode + mites (N+M)	2.80 b	2.29 b
Nematode + Vydate (N+V)	2.53 c	2.20 c
Control (CK)	------	-----
± SE	0.016	0.008
Chicken Manure (CM)		
Amended soil	2.21 a	1.93 a
Un-amended soil	2.39 b	2.05 b
± SE	0.011	0.006
Interactions		
T x CM	* * *	* * *
RSD	0.0674	0.0357

*** = P< 0.001 RSD = residual stander deviation

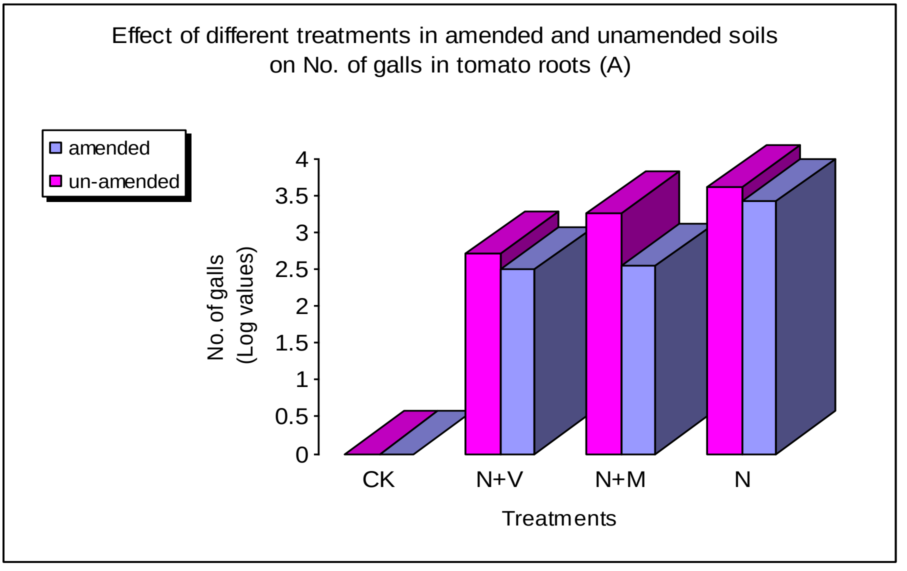
Means followed by the same letters within a column are not significantly different (P<0.05)

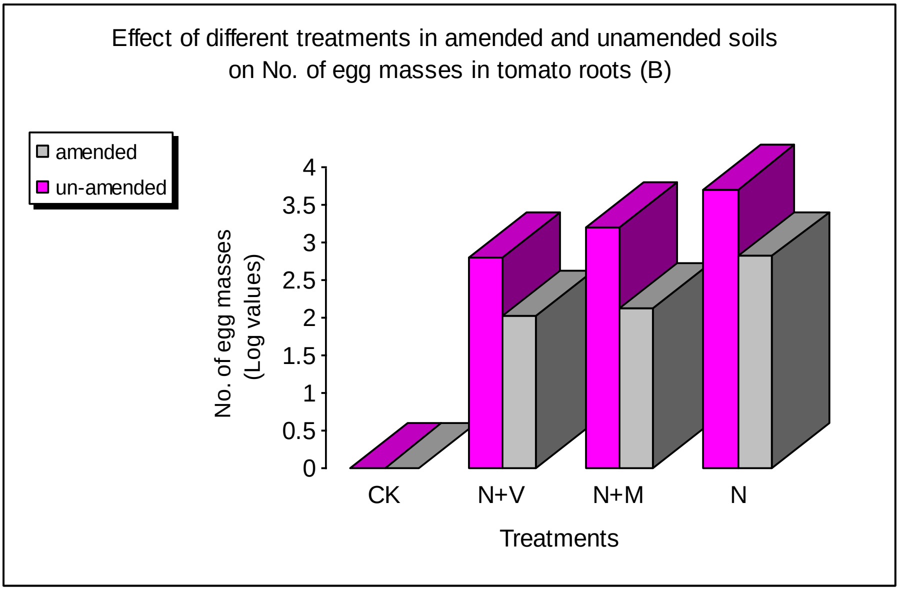
It was also noticed that chicken manure addition enhanced root development and gave better plant characteristics and that may be the reason for giving the mites better environment to exist especially in the upper surface area of soil. Karg (1983) stated that most mite species typically range from about $3x10^4$ to more than $3x10^5$ individuals/m2 in the top 15cm of soil. Therefore, root-knot nematode, which occurs near the soil surface surrounding root -system may be vulnerable to the mites (Al Rehiayani & Fouly, 2005).

Chicken manure clearly suppressed nematode development as number of galls and egg masses decreased (Table2). It is well known that some organic amendments have nematicidal activity against phytonematodes and the application of some organic materials may be sufficient to keep nematode population below the economic threshold level (Errico and Di Maio, 1980). Moreover, Maraeg (1984) found that cattle manure and pigeon dung reduced the population of *M. javanica* and increased plant growth. Accordingly, the value of chicken litter, as a fertilizer as well as suppressor of plant parasitic nematode populations and other soil pathogens, has been previously reported by many authors (Rodriguez-Kabana, 1986; Rodriguez-Kabana *et al*,1987 and Stirling, 1991). The toxic action of chicken manure on root-knot nematode, *M. javanica* may be due to the action of anhydrous NH_3 as nematotoxic compound as suggested by Canullo (1991) and Canullo *et al*, (1992). Hence, Rodriguez-Kapana, *et al*,(1995) clearly showed that adding of chicken manure significantly enhanced root and shoot characteristics and reduced numbers of galls of root-knot nematodes.

Accordingly, Fig.1(a-b) clearly showed that numbers of galls and egg masses were at their highest values when tomato were infected by nematodes alone while numbers significantly declined when mites or nematicide were added. The same trend was also observed when plants were transplanted in chicken manure amended or un-amended soils.

Concerning the mite reproduction index Pf / Pi, it averaged of 2.26 times after sixty days from nematode inoculation. This may indicate that acarid mite succeeded to develop and reproduce feeding on nematodes under greenhouse conditions. These findings agree with those obtained by Mostafa *et al*,(1997) who found that the mesostigmatid mite species *Laseiosius dentatus* had a reproduction index of 1.19 when it was introduced at the same time of root-knot nematode, *M. javanica* inoculation to citrus seedlings under greenhouse conditions. Al-Rehiayani and Fouly (2005) found that the reproduction index of the laelapid mite *Cosmolaelaps simple*x, fed on citrus nematodes *Tylenchulus semipenetrans*, was at its highest level when the predatory mites were added to the treatments at the same





Fig(1): Effect of the interaction of different treatments N(nematode), N+M(nematode+mite), N+V(nematode+Vydate) and control(CK) on number of galls (**A**) and egg masses (**B**) of *M. javanica* infecting tomato planted in chicken manure amended and un-amended soils.

time of nematode inoculation. That may be due to the mite species and its feeding behavior as well as to the biological aspects of nematodes. Moreover, the biological characteristics of the acarid mite *M. qassimi* may indicate to its potential as a biological control agent against root-knot nematode, *M. javanica* if it was introduced to the infected plants at the right time. Also, the relatively short life cycle and its high reproductive rate as noticed from the biological studies and life table parameters, allowed the mite population to increase as nematodes increased (Al-Rehiayani and Fouly, 2006). So the ability of the tested acarid mite (as omnivorous) to utilize alternative food sources (fungi, pollen) as well as nematodes in the same ecosystem are other advantageous characteristics as its great mobility and spatial range (Imbriani & Mankau, 1983; and Fouly, 1997).

From the previous results, it can be concluded that it is possible to use a mite species to manage root-knot nematodes, *M. javanica* especially at low nematode populations in greenhouses or small trials in the open field. Thus, mite capability to feed, survive and reproduce on nematodes can be integrated with other agricultural tactics such as the addition of chicken manure. Chicken manure, which is considered not expensive and readily available of N source, can be added alone for shoot and root improvement and that may be due to the acceleration of organic amendment to the microbial activity in the rhizosphere area. 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 and that what organic manure may provide. These findings are in harmony with those obtained by Rodriguez-Kapana *et al,* (1995). Therefore, the tested acarid mite, *M. qassimi* can be utilized as a biological control agent alone or mixed with chicken manure against root-knot nematode, *M. javanica.* Future work is highly needed to explore factors favoring substantial populations of nematode-destroying mites or other bio-agents

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تأثير الحلم الأكاريدي *Mycetoglyphus qassimi* (Acari : Acaridida) على نيماتودا تعقد الجذور *Meloidogyne javanica* – التى تصيب الطماطم في منطقة القصيم- المملكة العربية السعودية

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يهدف البحث إلى دراسة تأثير نوع من الأكاروسات المفترسة في خفض الإصابة بنيماتودا تعقد الجذور مقارنة باستخدام أحد المبيدات النيماتودية على شتلات الطماطم المنزرعة في تربة مسمدة عضوياً (مخلفات دجاج) أو غير مسمدة. تم جمع أفراد من النوع الأكاروسي *Mycetoglyphus qassimi* Al-Rehiayani and Fouly التابع لمجموعة الحلم الأكاريدي Acarid mites من عينات تربة حول المجموع الجذري لأشجار نخيل التمر *Phoenix dactylifera* L. في منطقة القصيم - المملكة العربية السعودية وإكثارها في المعمل بالتغذية على كتل بيض نيماتودا تعقد الجذور *Meloidogyn javanica* . أوضحت النتائج أن التسميد العضوي ساعد في زيادة النمو الجذري والخضري لشتلات الطماطم تحت الإختبار كما نشط دور المفترس الأكاروسي في خفض تعداد العقد النيماتودية وكتل البيض في التربة مقارنة بالمعاملات التي تمت عدواها بالنيماتودا فقط. وكان لإضافة الأكاروس المفترس *M. qassimi* أو المعاملة بالمبيد النيماتودي الفايديت (24%) أثر إيجابي على وزن المجموع الجذري والخضري للنباتات المعاملة بمقارنتها بالنباتات التي تمت عدواها بالنيماتودا فقط. وكانت للمعاملة بالمبيد التأثير الأعلى في خفض تعداد العقد النيماتودية على المجموع الجذري حوالي 80%. انخفض هذا التأثيرعند إضافة الأكاروس إلى 66%. وفي حالة الزراعة في تربة غير مسمدة عضوياً كانت نسبة الخفض في عدد العقد النيماتودية 95% عند المعاملة بالمبيد وكانت 95% عند إضافة الأكاروس المفترس في على الترتيب. وعند حساب فعالية المبيد والأكاروس المفترس في خفض عدد كتل بيض النيماتودا لوحظ أيضاً أن النسبة المئوية للخفض كانت أعلى عند استخدام المبيد من استخدام الأكاروس وخاصة في التربة المسمدة عضوياً. اتضح من تلك الدراسة أن المعاملة بالمبيد النيماتودي أو استخدام نوع الأكاروس *M. qassimi* يزيد من فعالية عملية مكافحة نيماتودا تعقد الجذور في نبات الطماطم.

الكلمات الدالة: الأكاروس المفترس *Mycetoglyphus qassimi* ، نيماتودا تعقد الجذور *Meloidogyne javanica*، نخيل التمر *Phoenix dactylifera* ، مكافحة حيوية