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STUDIES ON SOME ECOLOGICAL ASPECTS ON THE POPULATION DYNAMICS OF SOIL ACARI AND CITRUS NEMATODE UNDER CITRUS TREES IN EGYPT

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ABSTRACT

The obtained results cleared that the soil temperature and moisture had obvious role in increasing and decreasing nematode population.However, citrus nematode had four generations in the soil of Sefi orange and/or three generations in the roots throughout the year.The generation period varied from 2 to 3 months in the soil and from 3 to 4 months in the root of Sefi orange .

Seasonal variations in soil mite population density was representing as the total population of the four suborders i.e., Gamasida, Actinedida, Acaridida and Oribatida in the biotope of Sefi orange. The abundance of the total soil mite population was recorded in three peaks all year round. However, Gamasida and Acaridida had two peaks while there were tree peaks of oribatid mites throughout the year. The monthly abundance percentages of suborder Actinedida was highest in January.

Predacious soil mites had a role in controlling citrus nematode population where, gamasid mite increased in September, November,Decober, January, February, March, April and May , while citrus nematode population was decreased in the same months.

INTRODUCTION

Citrus is one of the economic fruit crops in Egypt. Citrus nematode, Tylenchulus semipenetrans is one of the most important citrus diseases which causes "slow decline" of citrus. In addition, some soil mites cause bad effects on citrus trees. These effects have not yet been cleared.

Different soil mites exhibit various associations with other organisms from phytophagy, predation, and parasitism to intricate commensal and phoretic relationships.

From these points of view, the present work was carried out to know the effect of some soil environmental factors on soil acari and citrus nematode population dynamics and the inter-relationships between some beneficial mites and the citrus nematode.

MATERIALS AND METHODS

A. Soil samples for citrus nematode, Tylenchulus semipenetrans and soil mites assay:

1. Citrus nematode:

Monthly, about 250 g. an aliquent of each composite soil sample for each replicate from the rhizosphere of the growing citrus trees was processed for nematode extraction by mixing the soil with water, then the suspension was placed in Baermann funnel for 72 hrs. The extracted nematodes were transferred to 150 ml beaker. Nematode enumeration was determined by using Hawksely counting slide and stereomicroscope.

2. Soil mites:

Monthly regular soil samples were collected, five soil cores were taken with a soil iron

sampler, each core 1000 cc, which were carefully mixed together and a volume of 1000 cc was taken from this mixture for each replicate and transferred to the laboratory in polyethylene bags . Samples were kept in a modified Tullgren apparatus with thin layers 1 - 2 cm for 48 - 72 hours. Extracted mites were kept in 70% ethyl alcohol .

Research microscope was used to identify and count all individuals of four soil mite suborders, using keys of Krantz (1978) and Zaher (1986).

B. Root samples for citrus nematode enumeration:

Monthly regular root samples were collected. Roots were washed carefully under running tap water in order to remove soil particles. A sample of 1 g. represented for each composite root sample for each replicate was immediately stained with lactophenol-acid fuchsin and stored in it for not less than 24 hrs. Nematode stages and egg-masses attached to roots were counted under a stereomicroscope.

C. Experimental design:

The experiment was carried out in the farm of the Faculty of Agriculture, Shebin El-Kom for one year from June 1988 to May 1989. Selected citrus trees (Citrus sinensis var. Sefi) were of the same size, height and vegetation, and naturally infected with citrus nematode. All agricultural practices, i.e. irrigation, stirring and fertilization were as the normal system of citrus orchards. Samples were replicated three times.

Data of nematode and soil mites were subjected to the analysis of variance test (ANOVA) with mean separation at 5% level of significance by L.S.D. test (Snedecor and Cochran, 1967).

RESULTS AND DISCUSSION

A. Major soil environmental factors affecting the population density of citrus nematode, Tylenchulus semipenetrans and soil mites :

1. Citrus nematode:

Population dynamics of citrus nematode in the soil and roots of Sefi orange during June 1988 - May 1989:

* In the soil:

Data depicted in Fig. 1A show that citrus nematode population was fluctuated in the rhizosphere of Sefi orange during the year under the present study, where the nematode population was very high in August, 1988. On the contrary it was very low in September,1988. The population was high in November,1988 and January and April,1989. On the other hand, it was low in June, July, October and December,1988 and February, March and May,1989. It seems that soil temperature and moisture (Fig. 1) had a role in increasing or decreasing nematode population.

Statistical analysis of the obtained data indicated that there is a significant difference in nematode population in the soil among months (L.S.D. at 5% = 57.9) i.e., there is a significant difference among August and all months. Also, among September and November, December,1988 and January, April and May,1989.

** In the roots:

Data illustrated in Fig. 1B show that citrus nematode population was varied during the

year of study. The nematode population was very high in December,1988 and January,1989. On the contrary it was very low in September,1988. On the other hand, it was high in July, August and November,1988, February, March and May,1989.But it was low in June and October,1988 and April , 1989. Soil temperature and moisture (Fig. 1)had a role in the seasonal fluctuation of citrus nematode.

Statistical analysis of the obtained data indicated that there is a significant difference in nematode population in the root of Sefi- orange (L.S.D. at 5% level = 1.3) i.e., there are significant differences among November,December and January as well as other months. Also,there are significant differences among September and other months.

Number of citrus nematode generation during June 1988 - May 1989 and generation period:

* In the soil:

Data depicted in Fig. 1A indicated that citrus nematode had four clear generations throughout the year in soil of Sefi orange. The generation period varied from 2 to 3 months.

** In the roots:

Data illustrated in Fig. 1B indicate that citrus nematode had only three remarkable generations in the roots of Sefi orange during the year. The generation period varied from 3 to 4 months.

These results agree with those of Vilardebo (1962) who studied the seasonal variations of T. semipenetrans and observed that there were very marked differences in the nematode behaviour according to the climatic conditions of its environment. Also, Toung (1963) added that these

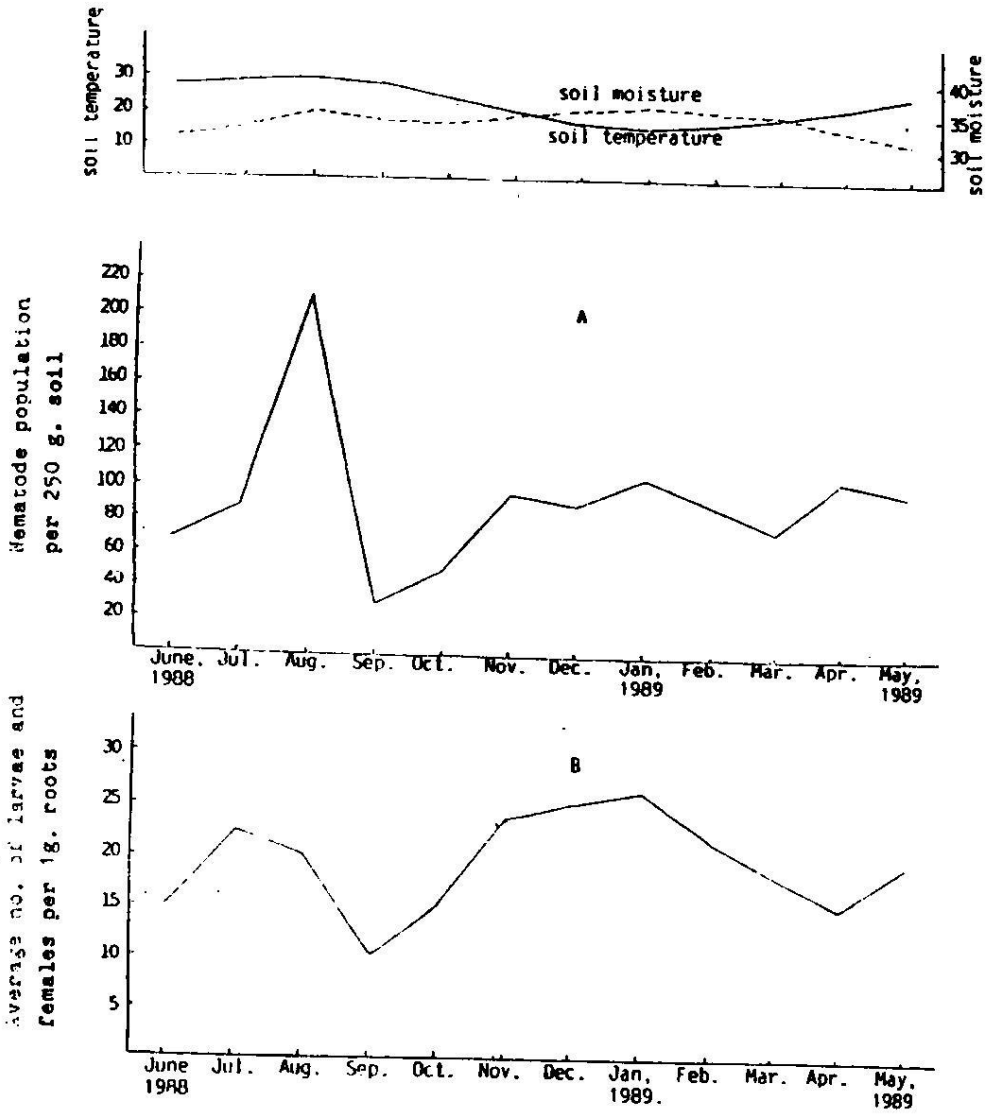

Fig. 1: Seasonal fluctuation of citrus nematode populations in the soil (A) and roots (B) of Citrus sinensis var. Nefi during June 1988 - May 1989.

fluctuations may be due to temperature changes. In addition, Yokoo (1964) observed that citrus nematode population seemed to be high in summer hot season, diminshing rapidly toward cold season. Jones (1977) indicated that the edaphic climatic temperature, moisture and aeration affecting nematode population. Salem et al (1984) founf that citrus nematode had 4,3 and 4 generations per year in both of soil and roots of C. sinensis var. Balady, in field experiment , respectively. They also added that the generation period ranged from 2 to 5 months.Recently, Sweelam and Salem (1989) found that there were five generations for citrus nematode per year on Coleopatra mandarin, while there were four generations on Sour orange, Rangpur lime, Volka mariana and Troyer citrange in a pot experiment at out doors temperature.

2. Soil mites:

Population dynamics of total soil mites:

Seasonal variations in the total soil mite population density was representing as four suborders i.e., Gamasida, Actinedida, Acaridida and Oribatida in the biotope of Sefi orange (Fig.2).

Statistical analysis of the obtained data showed significant differences among months (L. S.D. at 5% level = 4.9). Concerning the population density, it was clearly evident that the abundance of the total soil mite populations occurred throughout a year with 3 peaks in high numbers of soil mite individuals. The first peak was in July,1988; the second was in November of 1988 and the third one was in April of 1989 . Moreover, similar and moderate numbers of total soil mites occurred in other months.

The presented data are in harmony with those of Abd-Allah (1974) who reported that spring and autumn months were more suitable for reproduction

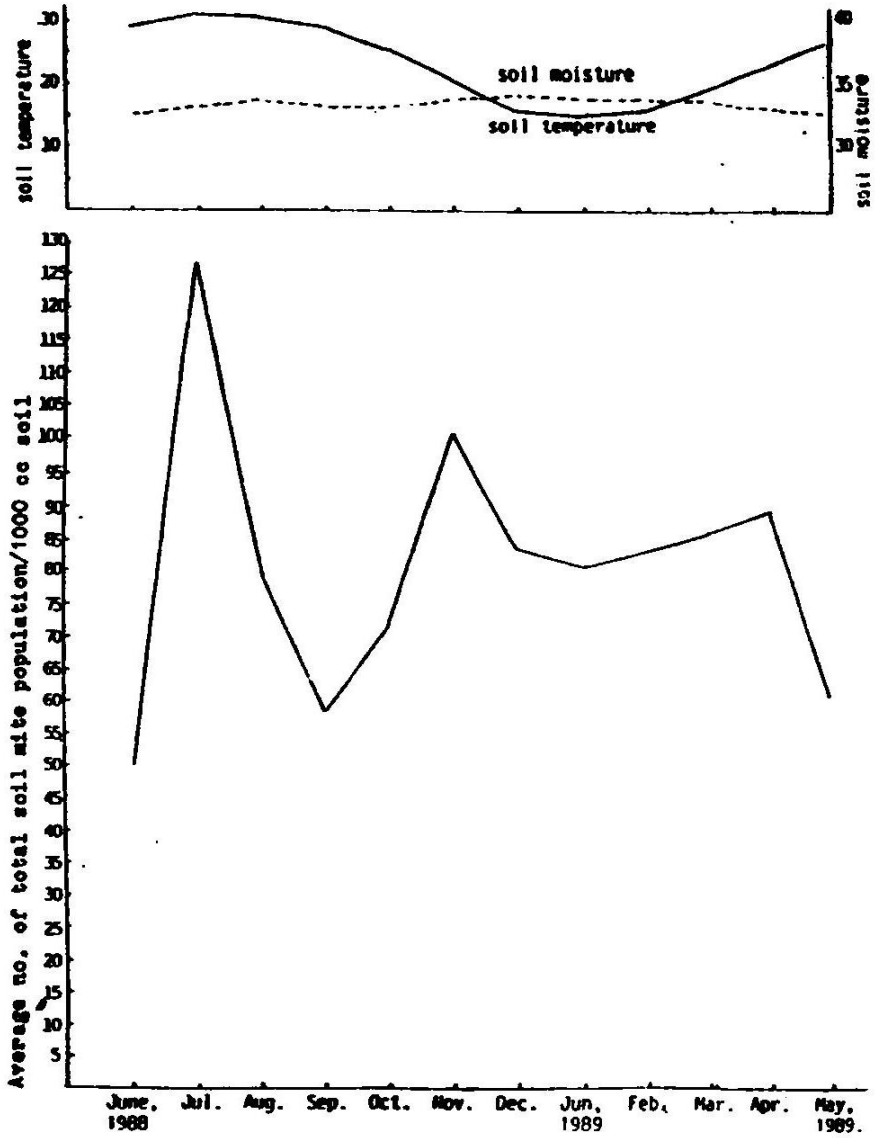

Fig. 2: Seasonal fluctuation of the total soil mite population inhabiting the soil of Sefi orange during June 1988 - May 1989.

of soil arthropods, but the drop was noticed during winter and summer months. Abo-Korab(1983) reported that in citrus orchards,population densities of soil mites were high in autumn and winter, while low populations existed in summer. Also, Zaki (1983) mentioned that many environmental factors play a role in the distribution of soil mites; i.e. soil temperature, moisture, rainfall, seasonal variations and amount of litter.

Generally, such distribution may be explained by other several factors, i.e. the clustering of eggs, the choice of microhabitats which are particulary suitable as a result of local conditions such as the microclimate; food etc., and the direct attraction between individuals (Edwards and Lofty, 1971). Moreover, some investigators attributed it to food and volume of the pore-space (Riha, 1951); temperature and vertical migrations (Kuhnelt, 1961) ; humidity (Madge, 1964); seasonal variations (El-Kifl et al., 1974) and the distribution of food sources (Usher, 1976).

Population dynamics of four mite suborders:

The monthly abundance percentages of the four mite suborders were illusterated in Fig. 3.

Statistical analysis of the obtained data showed significant defferences among the population density of the different four suborders (L. S.D. at 5% level = 4.0). In this respect, Gamasida had two peaks in September, 1988 and in April, 1989. Low proportions of gamasid mites population were observed in October, November and December of 1988. However, moderate abundances were occurred in the other months.

The monthly abundance percentages of suborder Actinedida was with highest proportion in January, 1989. However, the least percentages were in July, October and November of 1988.

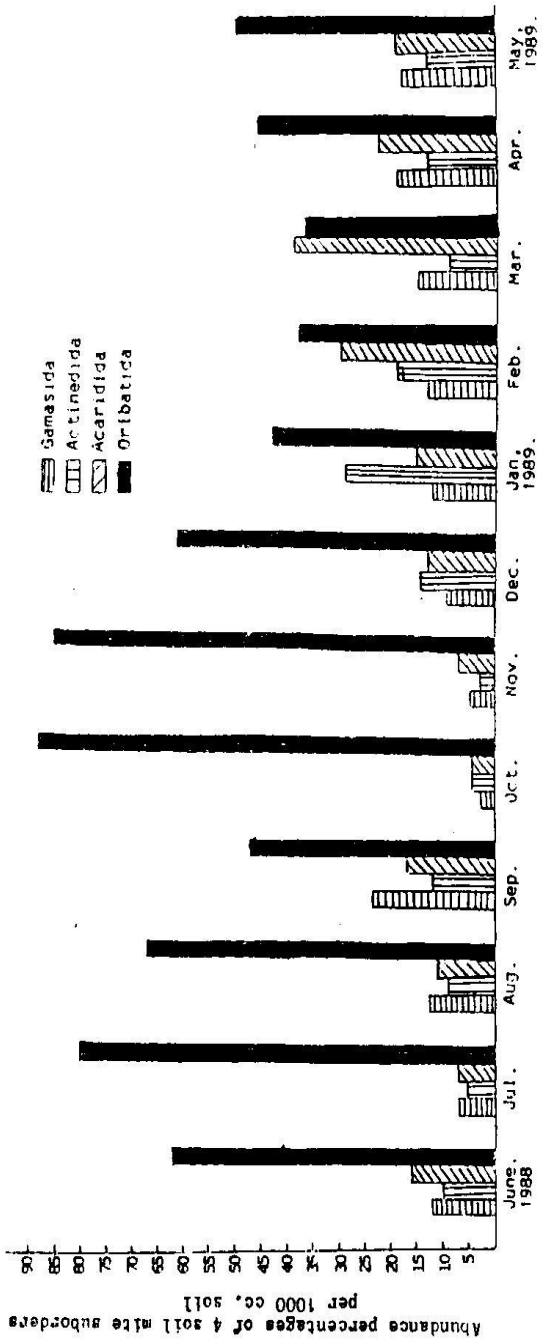

Fig. 3: Seasonal fluctuation of four soil mite suborders inhabiting the soil of Sefi orange during June 1988 - May 1989.

Concerning the population density of suborder Actinedida, there were two periods of high numbers, the first in February of 1989, and the second in March of 1989. The population density reached its minimum level in July, October and November of 1988.

It is clear that there were three remarkable peaks of oribatid mites with high percentages occurred in July, October and November of 1988. Mean while two other peaks with relatively moderate percentages occurred in December of 1988 and May of 1989. It is worthy to mention that the increase in the total populations at July, November of 1988 and April of 1989 may be due to the high occurrence of oribatid individuals comparing with other groups.

The individuals of Oribatida showed a distinct seasonal pattern, where litter of citrus biotope contained large numbers of oribatid individual all over the year. This suggests that oribatid mite species are occurred in aggregations. These data agree with Murphy (1955).

The present results are supportive of the findings of Tadros (1965) who found 13 species of oribatid mites in Giza and 7 species in Kafr El-Sheikh at the sametime. He attributed the short list at Kafr El-Sheikh to soil type , PH value , the percentages of both organic matter and microflora. Wafa et al. (1965)observed that minimal monthly mean of oribatid mites was in February and March. El-Kifl (1968) found that oribatids composed more than 83% of total soil mite fauna while other groups composed a small fraction of soil mite populations. Although , Abo-Korah and Salem (1981) found that Heterostigmata and Prostigmata had two peaks at February and May, while Mesostigmata and Astigmata had only one peak at March in citrus trees.

Abo-Korah (1983) found that Heterostigmata occurred in a great abundance contributed33.81%, while Astigmata constituted only 2.27%, Cryptostigmata 31.73%, Prostigmata 22.43% and Mesostigmata 9.64% represented groups of intermediate population levels, under citrus trees in Menoufia. The present study in the same area and same biotope indicated that Oribatida was the most abundant suborder, followed by Acaridida , then Actinedida and Gamasida represented 55.4%, 18.6%, 13.2% and 12.7%, respectively. Consequently, the occurrence of the different suborders may not only attributed to type of soil or different crops as mentioned by Abd El-Hamid (1972) but also to several other climatic factors.

B. Interrelationships between citrus nematode and soil mites in relation to citrus nematode control:

Predacious ground mite species are common in the upper layer of soil and in moss, humus, and animal waste products, where they feed on small arthropods or their eggs, on nematodes , and occasionally on each other. Typical predacious soil species may be found in many families of Gamasida and Actinedida. Members of the families Parasitidae, Macrochelidae, Ologamasidae , Halolaelapidae and Laelapidae are common gamasid predators of the littoral-intertidal zone, while predacious Actinedida include members of the families Bdellidae, Rhagidiidae, Cheyletidae and Erythraeidae (Luxton,1968; Lee,1970 and Costa , 1974).

Phytophagous ground species feed on roots, corms or bulbs. Some have chelate or dentate chelicerae for grinding and macerating plant tissues (Acaridida, Acaridae), while others have stylettiform chelae for piercing the plant cells

(Actinedida, Tarsonemidae)(Hussey et al.). Suborder Acaridida is primarily terrestrial mites which, with few exceptions are non-predatory in habit. Many species are saprophagous, fungivorous or graminivorous (Hughes 1961). The Oribatida are primarily fungivorous or saprophagous but also consume algae, bacteria, yeasts and higher plants. At least one moss-inhabiting species of Oribatida is known to supplement its normally saprophytic diet with live nematodes (Rockett and Woodring 1966). Other records of predation in Oribatida are cited by Luxton(1972).

It has been generally assumed that some prostigmatids (Actinedida) and mesostigmatids (Gamasida) are predacious, while cryptostigmatids (Oribatida) and astigmatids (Acaridida)are fungivorous and saprophagous (Wallwork 1967,1970, Luxton 1972 and Acki 1973).

Regarding to the data depicted in Figs. 1, 2 and 3 the population dynamics of both citrus nematode,T. semipenetrans, and soil mites, it seems that citrus nematode had low populations in summer (June, 1988), autumn (September and October, 1988) and spring (March and May, 1989). On the contrary, population density of soil mites, specially predacious mites, increased in the same periods. This may be explained the role of certain soil mites inhabiting soil and considered exclusively nematophagous mites.

It is worthy to mention that, in this investigation gamasid mite increased during autumn and spring seasons, on the contrary low existence of citrus nematode was observed. These data agree with the findings of Osman et al. (1988) who assurred that the highest predation rate on nematode was achieved by the predator macrochelid mite, Macrocheles muscaedomesticae (Scop.). However, many soil and dung-inhabiting mites are primarily or exclusively nematophagous and require a dependable source of nematodes for long-

term maintenance in laboratory cultures. Rhabditid and tylenchid nematodes have been used successfully as food sources for mite species representing a wide range of edaphic and coprophilous gamasid taxa (Walter 1987 and Walter et al. 1987).

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بعض الدراسات الايكولوجية على مجاميع حلم التربة ونيماتودا الموالح تحت أشجار الموالح

تناولت الدراسة النقاط التالية :

١- العوامل البيئية الرئيسية للتربة (الحرارة والرطوبة) وتأثيرها على نشاط مجتمع نيماتودا الموالح وأكاروسات التربة . أخذت عينات شهرية من منطقة الريزوسفير والجذور لأشجار البرتقال الصيفى بمزرعة كلية الزراعة بشبين الكوم فى الفترة مابين يونيو ١٩٨٨ وحتى مايو ١٩٨٩ وتم استخلاص حلم التربة من عينات التربة وتصنيفها الى مجاميعها على مختلف أنواعها وكذلك استخلاص النيماتودا من التربة والجذور وعدها .

٢- دراسة العلاقة بين نيماتودا الموالح وأكاروسات التربة وعلاقة ذلك بمكافحة نيماتودا الموالح .

ولقد أظهرت الدراسة النتائج الاتية :

١- كان لدرجة الحرارة ونسبة الرطوبة الارضية دورا هاما فى تذبذب مجتمع نيماتودا الموالح على مدار العام فى كل من التربة والجذور .

٢- كان لنيماتودا الموالح أربعة أجيال خلال العام فى منطقة الريزوسفير للبرتقال الصيفى وتتراوح مدة الجيل من ٢ - ٣ شهور أما في الجذور فقد كان لها ثلاثة أجيال فقط ومدة الجيل من ٣ - ٤ شهور .

٣- سجلت تحت الرتب الاتية من حلم التربة فى منطقة الريزوسفير للبرتقال الصيفى وهى Actinedida, Acaridida, Oribatida و Gamasida وكان لتعداد الاكاروسات فى التربة ثلاثة قمم peaks على مدار العام .

٤- كان لكل من تحت رتبتى Gamasida, Acaridida جيلين بينما كان هناك ثلاثة أجيال لتحت رتبة Oribatida بينما تراوحت أعدادتحت رتبة Actinedida خلال فصلى الربيع والشتاء .

٥- اختلف تواجد مجاميع الاكاروسات الاربعة على مدار العام ولقد كان ترتيب المجاميع من حيث تواجدها كما يلى من النسب الاتية :

Gamasida < Actinedida < Acaridida < Oribatida

١ر٥٥ ٠/٠ ، ١ر١٨ ٠/٠ ، ٢ر١٢ ٠/٠ ، ٧ر١١ ٠/٠ على التوالى .

٦- كان للحلم المفترس وبعفة خاصة تحت رتبة Gamasida دورا هاما فى خفض أعداد النيماتودا حيث أظهرت النتائج زيادة فى أعداد الـ Gamasida خلال شهور سبتمبر، نوفمبر، ديسمبر، يناير، فبراير، مارس ابريل، مايو ، فى نفس الوقت الذى إنخفضت فية أعداد النيماتودا، مما يعطى مؤشرا هاما لدور الاكاروسات المفترسة فى خفض اعداد نيماتودا الموالح المتطفلة على النبات .