RESULTS AND DISCUSSION

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1. The soil organisms in sugarbeet field at the Ten-thousand faddans area, West Nubaryia:

The aim of the present work is to present a survey of the soil arthropod and nematode fauna and microorganisms groups, which inhabit cultivated area by sugarbeet in the Ten-thousand faddans, West Nubaryia. Physical and chemical as well as fertility status of soil were determined to evaluate its effects on type and number of the soil organisms (Table, 3). These analyses showed that the soil could be classified as sandy soil. This soil contained distinctly low amount of organic matter (0.25%), and characterized by relatively low soluble cations and anions.

1.1. Animal fauna:

The numbers and types of animal fauna in sugarbeet fields during sowing season are stated in Tables (4a,b,c,and d). The obtained results were graphically illustrated in Figures (1a ,b and c).

1.1.1.Arthropod fauna:

Monthly means / m^2 soil of arthropod groups in sugarbeet field are shown in Tables (4a,b,c,and d) and Figure (1 a, b and c). Results showed that arthropod fauna composed about 13.84 % of the total soil animal fauna in sugarbeet soil. Also, population of arthropod fauna showed two consecutive peaks during sugarbeet growing season, one in February (113.52 $X10^3$ / m^2) and other in June (174.55$X10^3$ / m^2).

Table (3): Physiochemical characteristics and fertility status of the sand soil at the Ten-thousand faddans area, West Nubaryia region.

Soil properties	Values or/and discription
Soil depth, Cm	0 - 30
Soil texture	Sandy
E.C., DS M^{-1}	0.96
PH	8.09
Soluble cation, meq L^{-1}	
Ca^{2+}	2.72
Mg^{2+}	1.82
Na^{+}	4.27
K^{+}	0.79
Soluble anion, meq L^{-1}	
CO_2^{-3}	--
$HCO^{-}{}_3$	1.66
CL^{-}	6.81
SO_4^{-2}	1.13
Ca CO_3, %	9.74
O.M. %	0.25
N (ppm)	31.20
P (ppm)	3.10
K (pmm)	77.50

1.1.1.1. Arachnida fauna:

The arachnid fauna composed about 73.47 and 10.17 % of the total arthropod fauna and animal fauna, respectively. Three subclasses of the class Arachnida were recorded in the soil of sugarbeet fields. Numbers of subclass Acari constituted about 99.64 % of the total Arachnida. However, the two others subclasses, Aranea and Pseudoscorpiones were presented by very few specimens (0.22 and 0.08 %, respectively).

1.1.1.1.1. Acari fauna:

As shown in Table (4) and figure (1)b, the acari fauna composed about 73.25 % of the total arthropod fauna (10.14% of the total animal fauna). Four suborders of the acari were recorded, and the oribatid mites (suborder: Oribatida) showed the highest percentage (66.55 %), while the mites of the suborder Gamasida and Actinedida conistituted a small fraction of the total mites fauna (17.20% and 13.11%, respectively). However, mites of suborder Acaridida were present in very small fraction (3.15%) of the total mite fauna. Population monthly of numbers of suborder, Gamasida and Actinedida as a whole tended to be low from November till May and reached their abundance in June. The mites of Acaridida were found from January and increased gradually to June. However, mites of suborder Oribatida in the soil of sugarbeet field had two consecutive peaks, one in December and the other in June.

Generally, the minimal monthly average of soil mite fauna in sugarbeet field was noticed in November at sowing date (39.0 $X10^3/m^2$), while the maximal occurred in June at harvest date (151.81 $X10^3/m^2$) .

Table (4a) Monthly overall mean numbers of soil animal fauna categories in sugarbeet fields as "thousands" per square meter in the Ten-thousand faddans area, West Nubaryia region throughout the growing season of 1997/1998.

Inspected species	Nov.	Des.	Jan.	Feb.	March	April	May	June	Total No.	F% Gr.*	F% T.a**	F% T.f***
Arthropod fauna												
Class Arachnida												
Subclass Acari												
Subor Gamasida	6.9	10.84	10.41	11.28	13.45	22.55	23.86	26.46	125.75	17.20		
Subor Oribatida	26.48	40.77	38.6	44.24	50.75	87.61	95.86	102.36	486.67	66.55		
Subor Actinedida	5.62	9.98	9.99	10.84	12.58	13.88	15.61	17.35	95.85	13.11		
Subor Acaridida	0.0	0.0	2.17	2.6	2.65	4.77	5.2	5.64	23.03	3.15		
Sub Total	39	61.59	61.17	68.96	79.43	128.81	140.53	151.81	731.3	100	73.24	10.14
Subclass Araneae												
Order Araneida	0.25	0	0	0	0.2	0.3	0.45	0.46	1.66	100	0.17	0.023
Subclass Pseudoscorpions												
Or.Psudoscorpionida	0.1	0	0	0	0.05	0.11	0.15	0.2	0.60	100	0.06	0.008
Total Arachanid fauna	39.35	61.59	61.17	68.96	79.68	129.22	141.13	152.47	733.56	100	73.47	10.17

* = of group ** = of total arthropods *** = of total fauna

1.1.1.1.2. Araneae and Pseudoscorpions:

Subclasses Araneae (order: Araneida) and pseudoscorpions (order: Pseudoscorpionida) were presented by few specimens and did not exceed 0.17 and 0.06 % of the total arthropod fauna (0.023 and 0.008 % of total animal fauna.

Table (4b)

Inspected species	Nov.	Des.	Jan.	Feb.	March	April	May	June	Total No.	F% Gr. *	F% T.a **	F% T.f***
Arthropod fauna												
Class Insecta												
Order Collembola	22.35	29.7	48.75	42.3	24.6	23.25	14.7	13.2	218.85	84.38	21.92	3.03
Order Orthoptera	0.09	0.15	0.15	0.15	0.2	0.3	0.31	0.35	1.7	0.66		
Order Dermaptera	0.1	0.05	0.11	0.04	0.0	0.0	0.0	0.0	0.3	0.12		
Order Thysanoptera	0.33	0.02	0.03	0.04	0.11	0.14	0.17	0.35	1.19	0.46		
Order Homoptera	0.0	0.0	0.0	1.25	1.4	11.35	9.9	5.25	29.15	11.24		
Order Hemiptera.	0.0	0.0	0.1	0.41	0.45	0.62	0.75	0.95	3.28	1.26		
Order Lepdioptera	0.01	0.02	0.03	0.03	0.04	0.04	0.05	0.05	0.27	0.10		
Order Coleoptera	0.0	0.0	0.05	0.05	0.24	0.34	0.29	0.29	1.26	0.49		
Order Isoptera	0.0	0.0	0.0	0.0	0.0	0.15	0.21	0.24	0.61	0.24		
Order Diptera	0.09	0.09	0.12	0.13	0.19	0.17	0.15	0.15	1.09	0.42		
Order Hymenoptera	0.24	0.06	0.08	0.09	0.11	0.1	0.12	0.15	0.95	0.37		
Other insects	0.06	0.05	0.06	0.07	0.1	0.11	0.12	0.15	0.72	0.28		
Sub Total	23.27	30.14	49.48	44.56	27.44	36.57	26.77	21.13	259.36	100	25.98	3.60
Sub Total of Arthropods	64.04	93.08	111.03	113.52	107.33	166.09	168.79	174.55	998.43			13.84

* = of group ** = of arthropods *** = of total fauna

Table (4c)

Inspected species	Nov.	Des.	Jan.	Feb.	March	April	May	June	Total No.	F% Gr. *	F% T.a **	F% T.f
Class Myriopoda												
Order Pauropoda	0.45	0.47	0.13	0	0	0.05	0.04	0	1.14	60.32		
Order Diplopoda	0.22	0.28	0.25	0	0	0	0	0	0.75	39.68		
Sub Total	0.67	0.75	0.38	0	0	0.05	0.04	0	1.89	100	0.19	0.03
Class Crustecea												
Order Isopoda	0.75	0.6	0	0	0.21	0.25	0.85	0.95	3.61	100	0.36	0.05

* = of group ** = of arthropods *** = of total fauna

Table (4d)

Inspected species	Nov.	Des.	Jan.	Feb.	March	April	May	June	Total No.	F% Gr. *	F% T.n**	F% T.f***
Phylum Annelida												
Order Togadrilla	0.05	0.04	0.02	0.01	0.05	0.07	0.03	0.01	0.28	**100.0**		0.004
Phylum Mallusca												
Class Gastropoda	0.01	0.01	0.01	0.02	0.02	0.07	0.02	0.01	0.17	**100.0**		0.002
Phylum Nematodes												
Class Adenophorea												
Order Dorylaimida	24.23	37.3	36.87	40.34	46.84	80.24	84.58	93.25	443.65	30.91	7.14	6.15
Order Enoplida	13.18	31.62	30.97	34.18	39.32	67.72	71.58	78.43	367	25.56	5.90	5.09
Order Monochida	22.45	53.83	52.74	58.21	66.95	115.39	121.87	133.53	624.97	43.53	10.06	8.66
Sub Total the class	59.86	122.75	120.58	132.73	153.11	263.35	278.03	305.21	1435.62	**100.0**	**23.10**	**19.90**
Class Secernentea												
Order Diplogasterida	11.71	18.65	18.22	20.39	23.86	41.64	43.81	48.58	226.86	4.75	3.65	3.14
Order Rhabditida	15.24	23.42	21.25	25.59	29.49	50.75	53.35	60.29	279.38	5.84	4.50	3.86
Order Tylenchida	176.21	422.72	415.01	471.26	532.38	906.31	777.48	572.59	4273.96	89.41	68.75	59.25
Sub Total the class	203.16	464.79	454.48	517.24	585.73	998.70	874.64	681.46	4780.20	**100.0**	**76.90**	**66.25**
Sub Total of Nematodes	263.02	587.54	575.06	649.97	738.84	1262.05	1152.67	986.67	6214.82	**100.0**	**100.0**	**86.15**
Total fauna	**327.12**	**680.67**	**686.12**	**763.52**	**846.23**	**1428.28.**	**1321.51**	**1161.24**	**7213.66**			**100.0**

* = of group ** = of total nematodes *** = of total fauna

Figure (1a) Constitution of total fauna

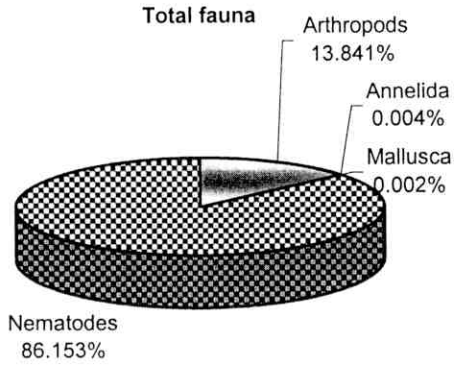


Figure (1b) Constitution of total Arthropod fauna

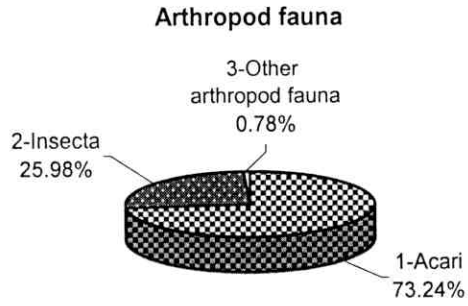
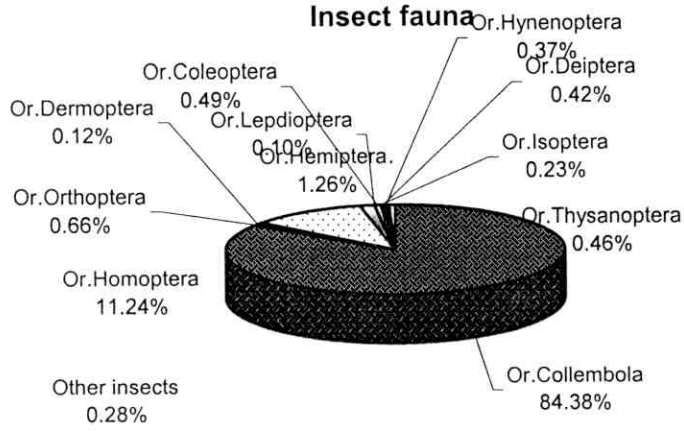


Figure (1c) Constitution of total Insect fauna



1.1.1.2. Insect fauna:

As indicated from Table (4b) and Figure (1c), the insect fauna in sugarbeet field stood next in magnitude after mite fauna in their distribution. They constituted about 25.98 % of the total arthropod fauna (3.6% of the total animal fauna). The Collembola formed 84.38 % of the total insect fauna (21.92% of the total arthropod fauna) .The insect orders, Coleoptera, Dermaptera, Diptera, Hemiptera, Homoptera Hymenoptera, Isoptera, Lepidoptera, Orthoptera, Thysanoptera and other insects formed a small fraction of the total insect fauna (15.62 %). On the other hand, the insect orders could be arranged in a descending order according to their relative abundance as follows, Collembola, Homoptera, Hemiptera, Orthoptera, Coleoptera, other insects, Diptera, Hymenoptera, Thysanoptera, Isoptera, Lepidoptera and Dermaptera.

Comparing the monthly occurrence of Collembola with the other order's insects, it could be concluded that the Collembola's population increased from November to their maximal in January after that decreased gradually from February to be low in June. Such a decrease occurred during season period at the crop maturing. However, the other insect orders, it may be mentioned that, two peaks of their abundance were observed in January and April during the sugarbeet growing season. Also, The orders, Coleoptera, Hemiptera, Homoptera and Isoptera did not occur in all months of growing season.

1.1.1.3. Other arthropod fauna:

Other arthropoda, such as class Myriopoda (orders, Pauropoda and Diplopoda) and class Grustacea (order, Isoptera),

were presented by few specimens and did not exceed 0.19 and 0.36 % of the total arthropod; and 0.03 and 0.05 % of animal fauna pronounced, respectively Table(4c).

1.1.2. Annelida and Mollusca fauna:

Annelida (Order Togadrilla) and Mollusca (Class Gastropoda) as soil animal fauna were collected at very low population densities in sugarbeet field with an average of 0.004 and 0.002 % of the total soil animal fauna, respectively (Table 4d and Figure, 1 a).

1.1.3.Nematode fauna :

As indicated from Table (4d) and Figure (1a), the nematode fauna in soil of sugarbeet field next in magnitude before arthropod fauna in their distribution. They constituted about 86.15 % of the total animal fauna. This phylum is presented by two classes namely, Adenophorea and Secernentea. The first implies orders Dorylaimida, Enopida and Mononchida (formed about 23.10 and 19.90% of total nematode fauna and total animal fauna, respectively) and the second evolves Diplogasterida, Rhabditida and Tylenchida (formed about 76.90 and 66.25% of total nematode fauna and total animal fauna, respectively). The Tylenchida formed 68.75 % of the total nematode fauna, however, the other nematode orders formed a small fraction. The nematode orders could be arranged in a descending order according to their relative abundance in the soil of sugarbeet field as follows: Tylenchida (86.75 %), Mononchida (10.06 %), Dorylaimida (7.14 %), Enoplida (5.91 %), Rhabditida (4.50 %) and Diplogasterida (3.65 %) as figured in Figure(1d).

The maximal monthly average of nematode fauna (1262.05 X 10^3/ m^2) was noticed in April, while the minimal (263.02 X 10^3/m^2) occurred in November.

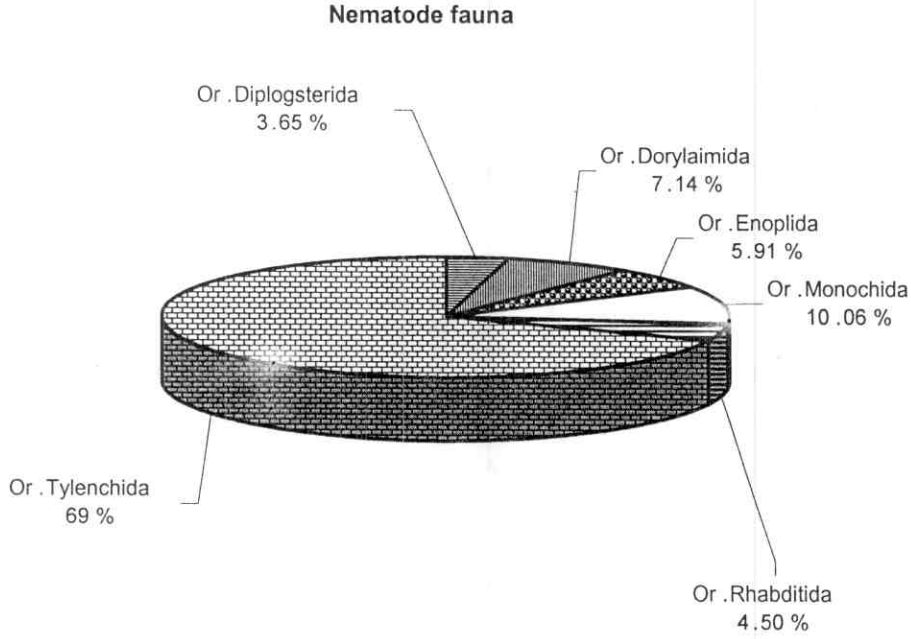


Figure (1 d): Constitution of nematode fauna

1.1.4. Monthly variations of predators (arthropod and nematode fauna) in sugarbeet field at theTen-thousand faddans area, West Nubaryia:

1.1.4.1. Predator arthropod fauna:

The numbers and types of predators fauna in sugarbeet field are showed in Table (5) and Figured in Figures (2 a,b and c). Predator soil arthropod fauna in this study can be represented by some members of mites and insects. The data revealed that, the predator mites comprised about 73.88% of the total arthropod fauna and the predator insect was the next in the magnitude (26.12%) as shown from Figure (2 a). However, the members of predator arthropod composed about 31.98% of the total predator fauna (Table 5). In general, the predator arthropode fauna were abundant only in April and June with population densities of 76.15 X 10^3 animal /m^2 and 180.14 X 10^3 animal /m^2, respectively

1.1.4.1.1. Predator mites:

During the investigation, seven species were belonging to the three suborder; Gamasida, Actinedida and Acaridida. Four species from Gamasida namely, *Platyseius major* Halbert (Fam: Accoseyjidae), *Macrocheles monchaolska* B. et K. (Fam: Macrochelidae), *Amblyseius messor* Wainstein (Fam: phytosiidae) and *Uropoda missella* Berlese (Fam: Uropodidae), two species from Actinedida; *Cheyletus malaccensis* Oudemans (Fam: Cheyletidae) and *Cunaxa sp.* (Fam: Cunaxidae) and one species, *Glycyphagus domesticus* De Geer (Fam: Glycyphagidae) from Acaridida were recorded in sugarbeet fields. The mites of Gamasida formed the highest percentage (64.65 %) of the total

number of the predator mite fauna followed by Actinedida (31.73%) and Acaridida (7.62%) as shown in Figure (2 b).

The monthly variation for each of the above mentioned mite species recorded in Table (5). The Gamasidid mite, *U. missella* made up the largest fraction (37.98%) of the recorded mite species. The common actinedid mite, *C. malaccensis* with an average percentage of 19.16 % of total predator mite fauna. Generally, predator mite species could be arranged in a descending order according to their relative abundance as follows: *U. misella*, *C. malaccensis, Cunaxa sp., M. monchaolska, A. messer, P. major* and *G. domesticus.*

The data show that predator mites composed about 23.58 % of the total predator animal fauna. Also, the predator mite population in sugarbeet soil as whole tended to be low from November till May and reached their abundance in June (Table 5).

Comparing the monthly occurrence of predator mites with nematode fauna, it could be concluded that the population of predator mites tended to increase with the increasing of the nematode population (Table 5).

1.1.4.1.2. Predator insects :

Collembolan insect, *Onychiurus armatus* Tüllberg (Fam: Onychiuridae) as predator insect in sugarbeet field increased gradually from November till March and reached their abundance in April after that decreased gradually till June. Also, this insect comprised about 8.31% of the total animal fauna. Generally, the predator arthropod fauna were abundant in two periods during growing season, the first from November till April and the second from May till June (Table 5).

Table (5) Monthly variations of members of predator arthropod and nematode fauna by thousands /m^2 soil in sugarbeet field at the ten thousand faddans area, West Nubaryia region throughout the growing season.

Inspected species	Nov.	Des.	Jan.	Feb.	March	April	May	June	Total No.	F% Gr.*	F% T.**
Acari fauna											
Suborder Gamasida (Mesostigmata)											
Fam. Accoseyijidae *Platyseius major*	1.38	1.92	1.84	2.00	3.38	5.01	5.30	5.87	25.70	7.76	1.83
Fam. Macrochelidae *Macrocheles monchaolska*	2.42	4.03	3.86	3.19	2.65	4.86	5.70	5.70	31.85	9.62	2.27
Fam. Phytosiidae *Amlyseius messor*	1.52	2.20	2.11	2.28	2.72	6.00	6.34	7.03	30.20	9.12	2.15
Fam. Uropodidae *Uropoda misella*	6.91	10.82	10.41	11.27	13.44	22.55	23.86	26.46	125.72	37.98	8.95
Suborder Actinedida (Prostigmata)											
Fam. Cheyletidae *Cheyletus malaccensis*	3.76	6.66	6.59	7.17	8.36	9.19	10.38	11.32	63.43	19.16	4.52
Fam. Cunaxidae *Cunaxa sp.*	1.86	3.32	3.40	3.67	4.22	4.70	5.24	6.03	32.44	9.80	2.31
Suborder Acaridida (Astigmata)											
Fam. Glycyphgidae *Glycyphgus domesticus*	0.00	0.00	2.17	2.60	2.65	4.77	5.20	5.64	23.03	6.96	1.64
Sub total Acari	17.85	28.95	30.38	32.18	36.42	57.08	61.46	68.05	330.13	100.0	23.58
Insect fauna											
Order Colembola Fam. Onychiuridae *Onychiurus armatus*	7.82	10.40	17.06	18.03	18.83	19.07	13.43	12.09	116.73	100.0	8.31
Total Arthropodes	25.67	39.35	47.44	50.21	55.25	76.15	74.89	80.14	446.86	100.0	31.98

* = of group ** = of total

Table (5): continued

Inspected species	Nov.	Des.	Jan.	Feb.	March	April	May	June	Total No.	F% Gr.*	F% T.**
Nematode fauna											
Order Diplogasterida											
Fam. Diplogaseridae *Diplogaster sp.*	11.71	18.65	18.22	20.39	23.86	41.64	43.81	48.58	48.58	23.78	16.15
Order Mononchida											
Fam. Mononchidae *Mononchus truncatus*	12.80	30.68	30.06	34.18	38.16	67.77	71.47	77.11	362.23	37.92	25.79
Mylonchulus hawaiiansis	9.65	23.15	22.68	24.03	28.79	47.62	50.40	56.42	262.74	27.50	18.71
Order Rhabdititda											
Fam. Rhabditidae *Rhabditis axei*	5.64	8.67	7.86	9.60	10.91	18.78	19.74	22.31	103.51	10.83	7.37
Sub total	39.80	81.15	78.82	88.20	101.72	175.81	185.42	204.42	955.34	100.0	68.02
Total fauna	65.47	120.50	126.26	138.41	156.97	251.96	260.31	284.56	1404.44	100.0	100.0

* = of group ** = of total

1.1.4.2.Predator nematode fauna:

As shown from Table (5), the predator nematodes in sugarbeet field increased to their maximal in June. More than 68.0 % of the predator fauna was nematode. Four species of nematodes were recorded with different relative abundance. The nematodes of the order Mononchida, *Mononchus truncatus* Butski and *Mylonchulus hawaiiansis* Barqri and Jairajpuri (Fam: Mononchidae) and of the order Diplogasterida, *Diplogaster sp.* Schultze (Fam: Diplogasteridae) conistituted a large fraction of the total predator nematode fauna (37.92, 27.50 and 23.75 %, in respect) , while the species nematode *Rhabditus axei* Dougherty (Order, Rhabditida, Fam: Rhabditidae) was noticed in a small fraction (10.83 %). The minimal monthly average of each nematode species and total nematodes was found in November (sowing date). While, the maximal occurred in June (harvest date). Also, the total predator animal fauna was gradually increased from November till June (Table 5).

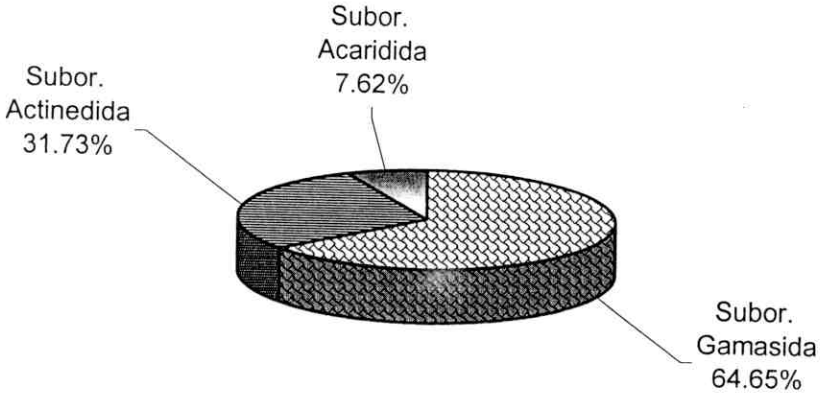


Figure (2) Constitution of predator acari fauna

2. Plant parasitic nematodes associated with sugarbeet in the ten thousand faddans area, West Nubaryia:

The different species of plant parasitic nematode associated with sugarbeet plants and their occurrence rate, absolute density, monthly fluctuation, importance value and prominence value are shown in Tables (6,7 and 8).

2.1. Species of plant parasitic nematodes:

From examined soil and root samples were collected from fields of sugarbeet in commonly cultivated in the Ten-thousand faddans area at West Nubaryia region. The data indicate that seven species of plant parasitic nematodes in these samples were found to be associated with sugarbeet plants. These species were; *Helicotylenchus dihystera* (Cobb, 1893) Sher 1961 (Fam: Hoplaimidae), *Macroposthonia. (Criconemoides) sp.* (Taylor, 1936) and Raski & Luc, 1985 (Fam: Criconemoidae), *Meloidogyne incognita* (Kafoid & White, 1919) Chitwood, 1949, *Meloidogyne javanica* (Treub, 1885) Chitwood, 1949 (Fam: Meloidogynidae), *Pratylenchus sp.* Filipjev, 1936 (Fam: Pratylenchidae), *Rotylenchulus reniformis* Linford & Oliveira, 1940 (Fam: Hoplolaimidae) and *Tylenchorhynchus sp.* Cobb, 1913 (Fam: Tylenchorynchidae). All these species are following order Tylenchida, their occurrence rate and absolute densities are presented in Table 6 and Figure 3.

2.2. Occurrence rate and absolute density:

The data appeare in Table 6 and Figure 3 appear that members of species, *H. dihystera, M. incognita, M. javanica and R. reniformis* were recoverd from most examined samples

and exhibited the highest occurrence rate: 80.00, 100.00, 81.00 and 78.02 %, respectively. The highest absolute density (2115.25 X 10^3 individual / m^2 soil) was detected with the root-knot nematode, *M. incognita* followed by the species *R. reniformis* and *H. dihystera* with an absolute densities of 759.18 X 10^3 and 509.15 X 10^3 individual / m^2 soil, respectively. *Pratylenchus sp.* and *Tylenchorhynchus sp.* were recorded in moderate occurrence rate (61.51 and 64.68 % of all examined samples, respectively) and found with a relatively high absolute densities (263.76 X 10^3 and 403.51 X 10^3 individuales / m^2 soil, respectively). On the other hand, the species *Macroposthonia sp.* seemed to be scarce and found in 43.65 % of the soil samples. Also, this species showed the lowest absolute density with an average number of 4.59 X 10^3 individuales / m^2 soil.

Table (6): Occurrence rate and absolute density / m^2 of plant parasitic nematodes associated with sugarbeet plants at the ten thousand faddans area, West Nubaryia region.

Nematode species	Occurrence rate (absolute frequency)	Absolute density in thousands / m^2
Helicotylenchus dihystera	80	509.15
Marcopothonia sp.	43.65	4.59
Meloidogyne incoginta	100	2115.25
Meloidogyne javanica	81	204.92
Pratylenchus sp.	61.51	263.76
Rotylenchulus reniformis	78.02	759.18
Tylenchorhynchus sp.	64.68	403.51

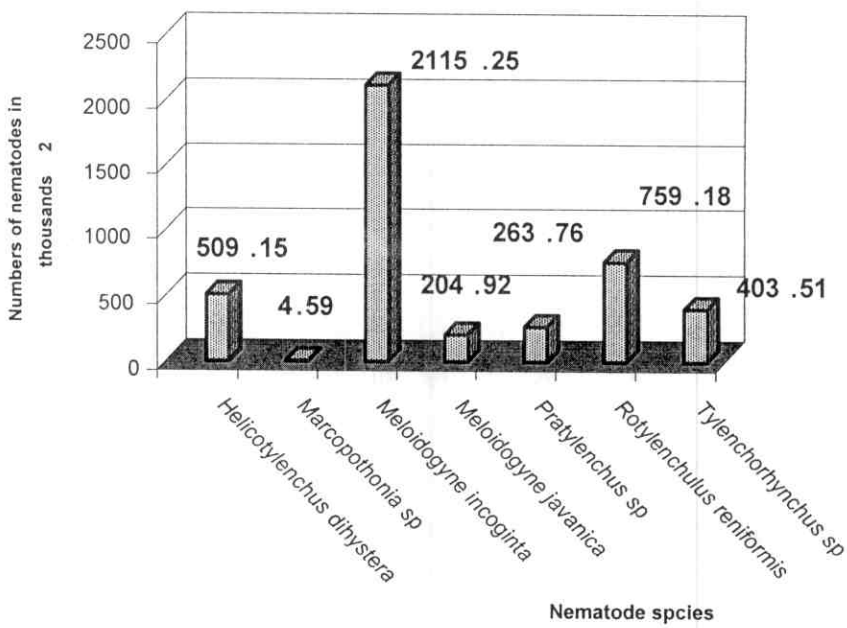


Figure (3): Absolute density / m² of plant parasitic nematodes associated with sugarbeet plants at the ten thousand faddans area, West Nubaryia region.

2.3. Monthly fluctuation and population densities through the growing season:

Aformentioned data, the plant parasitic nematode species found in the rhizosphere of sugarbeet plants located at the Ten-thousand faddans area in West Nubaryia region were *Helicotylenchus dihystera*, *Macroposthonia sp.*, *Meloidogyne incognita*, *Meloidogyne javanica*, *Pratylenchus sp.*, *Rotylenchulus reniformis* and *Tylenchorhynchus sp.* (Table 6). Their population densities in the soil samples of sugarbeet plants reflected the magnitude of nematode thriving in relation to the recorded soil temperature during growing season. Generally population density of each nematode species *H. dihystera sp., M. incognita, M. javanica, Pratylenchus sp., R. reniformis and Tylenchorhynchus sp.* began to increase from December till March and attained the high peak in April where soil temperature was 19° C, then gradually declined till June at 27° C of soil temperature.

Nematode species, *Macroposthonia sp.* was absent from November till February and recorded the lowest density in March, April, May, and June sampling months with an average of 0.89, 1.49, 1.27 and 0.94 X $10^3/m^2$ soil, respectively. *Meloidogyne incognita* species formed 49.65 % of the total nematode species. Whereas, *M. javanica* and *Pratylenchus sp.* observed in small fractions (4.81 and 6.19%, respectively). The nematode species could be arranged in descending order according to their relative abundance as follows; *M. incognita* (49.65 %), *R. reniformis* (17.82 %), *H. dihystera* (11.95 %), *Tylenchorhynchus sp.* (9.47 %), *Pratylenchus sp.* (6.19 %), *M.*

javanica (4.81 %) and *Macroposthonia sp.* (0.11 %) as shown in Tables (7&8).

Table (7) Monthly fluctuation of population densities in thousands /m^2 of plant parasitic nematode species under sugarbeet plants in the ten-thousand faddans area, West Nubaryia

Inspected species	Overall mean numbers of nematode / m^2										
	Nov.	Des.	Jan.	Feb.	March	April	May	June	Total No.	Average	F% T.**
Helicotylenchus dihystera	21.20	51.15	50.72	56.43	63.92	107.24	91.06	67.43	509.15	63.64	11.95
Marcopothonia sp.	0.00	0.00	0.00	0.00	0.89	1.49	1.27	0.94	4.59	0.57	0.11
Meloidogyne incoginta	89.86	215.80	211.90	233.67	264.73	442.00	378.04	279.25	2115.25	264.41	49.65
Meloidogyne javanica	8.62	20.14	20.27	22.85	25.89	43.22	36.57	27.36	204.92	25.62	4.81
Pratylenchus sp.	10.61	25.49	23.43	23.21	30.38	60.71	51.58	38.35	263.76	32.97	6.19
Rotylenchulus reniformis	29.59	70.40	69.63	80.09	95.77	166.37	142.22	105.11	759.18	94.90	17.82
Tylenchorhynchus sp.	16.48	39.75	39.06	44.28	50.81	85.81	73.11	54.21	403.51	50.44	9.47
Monthly mean temprature(c°)	20.7	14.0	14.3	14.7	17.0	19.0	24.3	27.3			

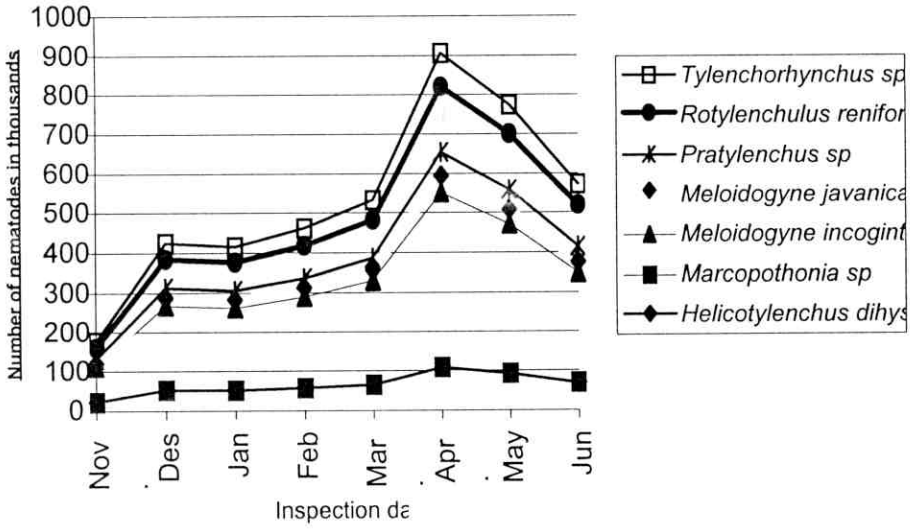


Figure (4): Monthly fluctuation of population densities in thousands /m^2 soil of plant parasitic nematode species under sugarbeet plants .

2.4. "Importance and Prominence" values :

Importance value and prominence value as well as absolute biomass per ug/m² nematodes associated with sugarbeet plants tabulated in Table (8). The importance value is an estimation expresses the importance of nematode species in a community and equals relative density % + relative biomass % + relative frequency %. While, the relationship of population density and frequency can be expressed as a prominence value which is a set of determinations based on the absolute density and frequency per species (Norton, !978). The highest importance value (100.11) was recorded with *M. incognita* followed by 49.68, 47.57 and 44.22 with *R. reniformis*, *Tylenchorhynchus sp.* and *H. dihystera*, respectively. On the other hand, *M. javanica* and *Pratylenchus sp.* were showed the important value with an average of 24.97 and 23.93, respectively. While, the lowest importance value (9.52) was found with *Macroppposthonia sp.* as shown in Table (8).

Concerning " prominence value " which is an independent calculation for the rate of prominence of each species equals density $\sqrt{}$ frequency was determined in thousands. The highest value of 21152.50 was observed with M. incognita, while the lowest value (30.33) was found with *Macroposthonia sp.* On the other hand, the other species, *H. dihystera, M. javanica, Pratylenchus sp., R. reniformis* and *Tylenchorhynchus sp.* had moderate prominence values with an average of 4553.98; 1844.28; 2068.63; 6705.76 and 3245.18, respectively (Table, 8).

The results in Table (8) also, indicated that absolute biomass per µg/m² soil ranged between 8620.01 – 319718.32 µg

nematodes / m^2. Nematodes of *M. incognita* had the greatest biomass value (319718.32) followed by *Tylenchorhynchus sp.* (263494.06), *H. dihystera* (171700.14), *R. reniformis* (the 171545.02) and *M. javanica* (43939.33), while *Macroposthonia sp.* nematodes had the least biomass value (8620.01).

In general, root-knot nematodes (*Meloidogyne spp.*) were found in high occurrence rate in all soil and root samples that were collected from sugarbeet fields at the Ten-thousand faddans area. While, *M. incognita* was dominant species and had highest "Importance and Prominence values" in sugarbeet fields (Table 8).

It could be considered as potential economic pest of sugarbeet crop, those results confirm the records reported by Grujicic and Paunouic (1971), Abd-El-Massih (1985), Maareg *et al.* (1988 and 1998) and Ismail *et al.* (1996).

Table (8) The " Importance " and " Prominence "values and their relevance for plant parasitic nematodes Associated with sugarbeet plants in the ten-thousand faddans area, West Nubaryia region.

Nematode species	Relative density	Frequency relative	Absolute biomass $\mu g/m^2$	Relative Biomass	Importance value	Prominence Value
Helicotylenchus dihystera	11.95	15.72	171700.14	16.55	44.22	4553.98
Marcopothonia sp.	0.11	8.58	8620.01	00.83	9.52	30.33
Meloidogyne incoginta	49.65	19.65	319718.32	30.81	100.11	21152.50
Meloidogyne javanica	4.81	15.92	43939.33	4.24	24.97	1844.28
Pratylenchus sp.	6.19	12.09	58589.79	5.65	23.93	2068.63
Rotylenchulus reniformis	17.82	15.33	171545.02	16.53	49.68	6705.76
Tylenchorhynchus sp.	9.47	12.71	263494.06	25.39	47.57	3245.18
Total	100.00	100.00	1037606.67	100.00		

3. Field population dynamics of the *Meloidogyne incognita* at different growth stages of sugarbeet plant:

The results of population dynamics of *M. incognita stages* (juveniles larvae in soil and total stages and egg-masses /root) at five different growth stages (45, 90, 135, 180 and 210 days age) of sugarbeet plant under field conditions are presented in Table (9) and Figure (5). These results indicate that the number of juvenile larvae in soil was significant increased as sugarbeet age increased up to 210 days age. Similar trend was obtained in the number of nematode total stages in root system. Number of juveniles larvae in soil increased by 193.3, 383.3, 401.2, 867.9 and 479.5 % at 45, 90, 135, 180 and 210 days after sowing, respectively compared with initial population number. Whereas, total stages number in root was 229.8, 293.5, 307.5, 369.3 and 201.0 at the five mentioned growth stages of sugarbeet, respectively. The maximum number of juvenile larvae in soil and total stages in root (1084.0 and 369.3, respectively was recorded with growth stage of 180 days after sowing.

Also, final population of *M. incognita* nematode increased with increasing sugarbeet age up to 210 days growth stage. The increase percentages were 41801, 687.3, 729.7, 1265.4 and 729.5 % as compared with initial population at 45, 90, 135, 180 and 210 days after sowing, respectively. The differences among values of final population at all growth stages were significant as compared with initial population (at sowing date). Without significant differences between 135 and 210 days of growth stages (days after sowing).

Table (9): Field population dynamics of *Meloidogyne incognita* at different growth stages of sugarbeet plants in the ten -thousand faddans area, West Nubaryia region.

Sugarbeet age stage per days	Average numbers of *Meloidogyne incognita*, second stage juveniles (J2) in 300 gm soil, total stage (Ts) and egg-masses (Em) and total final population in root + soil / plant.			
	J2	Ts	Em	Total final population in root + soil / plant
Zero (initial population)	112.0	0	0	112.0
45	328.5	229.8	22.0	580.3
90	541.3	293.5	47.0	881.8
135	561.3	307.5	61.5	929.3
180 (harvesting date)	1084.0	369.3	76.0	1529.3
210 (final population)	649.0	201.0	79.0	929.0
L.S.D. 0.05	24.4	11.4	3.2	38.7
0.01	33.8	15.9	4.4	53.7

Generally, the numbers of juvenile larvae in soil, total stages in root system and final population of *M. incognita* nematode progressively increased as plants advansed twards maturity and reached its maximum value at 180 days after sowing, then decreased at the growth stage of 210 days after sowing (harvesting date), then its decreased due to water-fasting of plant for increasing sugar content in sugarbeet roots.

Number of egg-masses in root system increased significantly by increasing age of sugarbeet up to 210 days after sowing, without significant difference between 180 and 210 days after sowing. Egg-masses numbers were 22.0, 47.0, 61.5, 76.0 and 971 roots, respectively at 45, 90, 135, 180 and 210 days after sowing. Generally, egg-masses number progressively increased as plant advanced towards maturity and reached its maximum number at 210 days stage (Maturity stage) as shown in Table (9) and Figure (5).

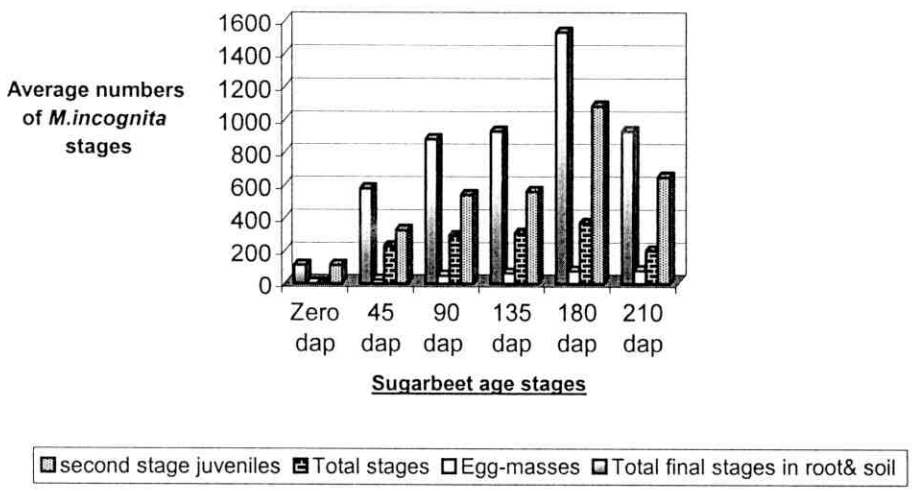


Figure (5): Field population dynamics of *Meloidogyne incognita* at different growth stages of sugarbeet plants in the Ten-thousand faddans area, West Nubaryia region.

4. Relationship between soil microorganisms and *Meloidogyne incognita* :

4.1. Bacterial and fungal isolates:

Table (10) illustrated different bacteria and fungi, which were isolated from soil and root samples collected from sugarbeet fields at the Ten-thousand faddans, West Nubaryia, Egypt.

Table (10): A list of the isolated and identified bacteria and fungi.

No.	Bacteria species	No.	Fungi species
1	*Arthrobacter sp.*	1	*Aspergillus niger*
2	*Bacillus cereus*	2	*Aspergillus humicola*
3	*Bacillus subtilis*	3	*Aspergillus flavus*
4	*Corynebacterium sp.*	4	*Aspergillus parasiticus*
5	*Pseudomonas fluorescens*	5	*Penecillium frequentals*
6	*Serratia odorifera*	6	*Penecillium nigricans*
7	*Streptomyces sp.*	7	*Penecillium spinulosum*
		8	*Trichoderma harzianum*
		9	*Trichoderma viride*
		10	*Verticillium chlamydosporium*

4.1.1. Fungal isolates :

Also, all isolated fungi were purified and identified into ten species, *Aspergillus niger, A. humicola, A. flavus, A. parasiticus, Penecillium frequentals, P. nigricans, P. spinulosum, Trichoderma herzianum, T. viride* and *Verticillium chlamydosporium.*

4.1.2. Bacterial isolates :

All isolated bacteria were purified and identified into seven species, *Arthrobacter sp., Bacillus cereus, B. subtilis, Corynebacterium sp., Pseudomonas fluorescens, Serratia odorifera* and *Streptomyces sp.*

The colonized fungi and / or bacteria filtrates screened for the nematicidal activity against the juveniles larvae of *M. incognita* in the laboratory and greenhouse.

4.2. Effects of soil fungi and bacteria on the *Meloidogyne incognita* population and productivity of sugarbeet :

4.2.1. Soil fungi :

4.2.1.1. Laboratory bio-assay test:

Percentage mortality of *M. incognita* juvenile larvae with *Aspergillus humicola, A. flavus, A. niger, A. parasiticus, Penicillium frequentals, P. nigricans, P. spinulosum, Trichoderma harzianum, T. viride* and *Verticillium chlamydosporium* filtrates are presented in Table (11). It is apparent that filtrates types affected the inhibition of nematode activity. Significant mortality percentage was obtained in all fungal filtrates treatments without exception, among *A. flavus*, A.

niger, *T. harzianum* and *T. viride* fungal filtrates treatments. Under the present bioassay experiment, nematicidal activity of the different fungal filtrates tested against *M. incognita* juvenile larvae could be arranged in a descending order as follows: *A. niger* (97.25% mortality) = *T. harzianum* (97.25%) > *T. viride* (94.75%) > *A. falvus* (94.50%) > *V. chlamydosporium* (86.50%) > *A. parasiticus* (78.50%) > *P. nigricans* (77.0%) > *A. humicola* (73.0%) > *P. frequentals* (70.25%) and *P. spinulosum* (66.25%). Consequently, it appears from the results that the fungal filtrates of *A. niger* and *T. harzianum* were the most effective filtrates followed by *T. viride*, *A. flavus* and *V. chlamydosporium*, while *P. spinulosum* filtrate was the least effective one on *M. incognita* juvenile larvae.

Table (11): Percentage mortality of *Meloidogyne incognita* juvenile larvae treated with ten fungal filtrates in laboratory bioassay test.

Fungi species	Mort (%)	Fungi species	Mort (%)
Aspergillus flavus	94.50	*Penecillium nigricans*	77.00
Aspergillus humicola	73.00	*Penecillium spinulosum*	66.25
Aspergillus niger	97.25	*Trichoderma harzianum*	97.25
Aspergillus parasiticus	78.50	*Trichoderma viride*	94.75
Penecillium frequentals	70.25	*Verticillium chlamydosporium*	86.50
L.S.D. 0.05 3.51 0.01 3.76			

Mort = Mortality % is corrected according to Abbott's formula (1925).

The differences in response of *M. incognita* larvae to the filtrates of fungi may be due to the differences in the native of toxic metabolites produced by the different fungal filtrates. The present results are in accordance with the findings of Dahiya and Singh (1985) they reported that toxicity of culture filtrate of the fungus, *A. niger* killed 93.3% of all second stage larvae of *M. incognita*. Abdel-Rahman (1999 b) found also that fungal filtrate of *A. niger* caused 88.0% mortality of the second stage larvae of *M. incognita*. Moreover, Abdel-Bari *et al.* (2000) reported that *A. niger, A. flavus, T. herzianum* and *T. viride* filtrates killed more than 90% of *M. incognita* juvenile larvae. However, Badr (2001) stated that the fungal filtrate of *A. niger* was the most effective against *M. javanica* juvenile larvae, while those of *T. harzianum* and *T. viride* were the least effective ones.

4.2.1.2. Greenhouse test:

Pots experiment was designed for studying the effect of some soil fungi on the control of *M. incognita* on sugarbeet. The soil fungi used were *A. flavus, A. niger, P. nigricans, T. harzianum, T. viride* and *V. chlamydosporium.* The results in Table (12) indicate that all tested fungi significantly reduced the number of galls, females and egg-masses as well as reproduction rate on roots of sugarbeet and juvenile larvae in soil of *M. incognita* nematode, compared with check treatment.

The fungus, *V. chlamydosporium* was the highest effective (67% reduction) against *M. incognita* galls formation on sugarbeet followed by *A. niger* (61.6%), *T. harzianum* (58.9%) and *A. flavus* (52.7%), while the fungus, *P. nigricans* was less

effective (43.8%) one. Statistical differences were not observed among *A. flavus, T. harzianum* and *T. viride* for gall number.

The fungus, *A. niger* was the most efficient treatment, eliminating average of 55.0% of females' number of *M. incognita* in sugarbeet roots. The second rank of efficiency was occupied by *V. chlamydosporium* fungus, 53.0% females' reduction. Generally, the other fungal treatments resulted in poor effect in reducing females' number, ranging between 29% in case of *T. viride* and 39% in case of *T. harzianum*. The differences among *P. nigricans, A. flavus, T. harzianum* and *T. viride* fungal treatments were not significant for number of *M. incognita* females.

Concerning egg-masses number, the most hazard effect came from *V. chlamydosporium* fungus treatment, 89.9% egg-masses reduction. *T. harzianum* eliminated 57.1% of the egg-masses number. However, the remaining fungal treatments look intermediate values in reducing egg-masses number ranging between 65.5% for *P. nigricans* and 68.9% for *A. flavus*. Statistically differences were not observed among *P. nigricans, A. niger, A. flavus* and *T. viride* fungal treatments.

Data obtained on juvenile larvae in soil (Table,12) revealed that the two fungi, *V. chlamydosporium* and A. niger proved to be the most toxic against juvenile larvae of *M. incognita*, as they eliminated 58.1 and 54.6% of it number, respectively. On the other hand, *T. viride* was the less (29.0%) toxic. Also, the other fungal treatments, *P. nigricans, A. flavus* and *T. harziaum* gave moderate results as hazardous to juvenile

larvae, as they reduced their population by 31.6, 39.2 and 47.8% reduction, respectively.

Only *V. chlamydosporium* fungus proved to be severely hazardous on *M. incognita* removing 62.6% of the reproduction rate. Relatively, treatments of *P. nigricans, A. flavus* and *T. viride* could be considered hazardous on this nematode, as they reduced their reproduction rate by 30.8, 33.9 and 34.6% reduction, respectively. The other treatments (*A. niger and T. harzianum*) caused negligible reduction rate of *M. incognita* (13.3 and 16.2% reduction, respectively).

From the previous results, it could be noticed that inoculation of sugarbeet with *V. chlamydosporium, A. niger* and *T. harzianum* fungi (separately) showed significantly suppressed *M. incognita* (numbers of galls, females and egg-masses as well as reproduction rate in root, and number of juvenile larvae in soil).

This effects may be due to potentially of such fungi to produce anti-nematodes compounds against penetration, development and reproduction of nematode on root and soil (Mankau, 1969; Khan *et al.*, 1978&1984; Maareg, 1984; Curl and Truelone, 1986; and Windham, 1989) or effect hatching of larvae of *M. incognita* (Sharma and Saxena, 1992; De Leij *et al.*, 1992 and 1993; El-Hadidy, 1996; Aboul-Eid and Youssef, 1998; Amin and Mostafa, 2000 and Maareg and Badr, 2000).

Table (12): Effect of six selected soil fungi on controlling Meloidogyne incognita infecting sugarbeet plants.

Treatments	Galls		Females		Egg-masses		Juveniles		Reproduction	
	Number per root	Reduction %	No. per root	Reduction %	No. per root	Reduction %	No. per root	Reduction %	Rate	Reduc--tion %
M.i.	112	0.0	100	0.0	119	0.0	1565	0.0	54.3	0.0
M.i.+A.f.	53	52.7	66	34.0	37	68.9	951	39.2	35.9	33.9
M.i. + A.n.	43	61.6	45	55.0	40	66.4	711	54.6	47.1	13.3
M.i. + P.n.	63	43.8	68	32.0	41	65.5	1071	31.6	37.6	30.8
M.i. + T.h.	46	58.9	61	39.0	51	57.1	817	47.8	45.5	16.2
M.i. + T.v	55	50.9	71	29.0	39	67.2	1111	29.0	35.5	34.6
M.i. + V.c.	37	67.0	47	53.0	12	89.9	656	58.1	20.3	62.6
L.S.D. 0.05	10.2		14.4		4.4		178.		4.44	
L.S.D. 0.01	14.2		20.1		6.1		248.		6.16	

M.i. = *Meloidogyne incognita*, A.f. = *Aspergillus flavus*,
A.n. = *Aspergillus niger*
P.n. = *Penecillium nigricans*, T.h. = *Trichoderma harzianum*
T.v. = *Trichoderma viride*, V.c. = *Verticillium chlamydosporium*

The data in Table (13) show the effect of soil fungal isolates (*A. flavus, A. niger, P. nigricans, T. harzianum, T. viride* and *V. chlamydosporium*) on growth of sugarbeet. The results showed that the inoculation with *M. incognita* reduced a reduction percentage of 12.8, 15.5, 24.0 35.2 and 28.6% root length, root diameter, root weight, foliage weight and plant weight, respectively compared with uninoculated plants treatment. The highest increase in sugarbeet growth (25.1% in root length, 26.8% in root diameter, 139.6% in root weight, 155.6% in foliage weight and 146.1% in plant weight) was obtained by the treatment of *V. chlamydosporium* fungus followed by *A. niger* fungus (which gave increase, 24.2, 23.7, 127.8, 143.0 and 134.0% in root length, root diameter, root weight, foliage weight and plant weight, respectively) and *T. harzianum* (21.9, 21.6, 124.6, 139.6 and 130.8% increase in above parameters, respectively). However, *T. viride* fungus treatments gave a lowest increase in these growth parameters of sugarbeet compared with the check treatment (nematode alone). All treatments significantly increased growth parameters when compared to those of the nematode alone (Table,13).

Table (13): Effect of six selected soil fungi on the growth parameters of sugarbeet plants as influenced by the infection of *Meloidogyne incognita*.

Treatments	Root length		Root diameter		Root weight		Foliage weight		Plant weight	
	cm	Increase (%)	cm	Increase (%)	gm	Increase (%)	gm	Increase (%)	gm	Increase (%)
M.i. only	21.9	0.0	9.7	0.0	235.0	0.0	163.0	0.0	389.9	0.0
Untreated	23.0	5.0	10.9	12.4	377.5	60.6	205.0	30.9	582.5	49.3
M.i. + A.f.	26.5	21.0	11.8	21.6	522.5	122.3	388.7	137.2	911.2	128.4
M.i. + A.n.	27.2	24.2	12.0	23.7	535.3	127.8	398.2	143.0	933.5	134.0
M.i. + P.n.	25.1	14.6	11.3	16.5	512.7	118.2	381.4	132.7	894.1	124.1
M.i. + T.h.	26.7	21.9	11.8	21.6	527.9	124.6	392.7	139.6	920.6	130.8
M.i. + T.v.	25.7	17.4	11.2	15.5	504.1	114.5	375.0	128.8	879.1	120.4
M.i. + V.c.	27.4	25.1	12.3	26.8	563.0	139.6	418.8	155.5	981.8	146.1
L.S.D. 0.05	2.00		0.77		24.33		8.39		13.04	
0.01	2.78		1.07		33.63	0.0	11.64		18.10	

M.i. = *Meloidogyne incognita*, A.f. = *Aspergillus flavus*,

A.n. = *Aspergillus niger* P.n. = *Penecillium nigricans*,

T.h. = *Trichoderma harzianum* T.v. = *Trichoderma viride*,

V.c. = *Verticillium chlamydosporium*

The data in Table (14) show the effect of soil fungal isolates on the quality characters, total soluble solids (T.S.S), sucrose and purity and sugar yield per plant of sugarbeet plants. Data indicate that the inoculation with *M. incognita* juveniles reduced a reduction in total soluble solids (T.S.S.%), sucrose %, purity % and sugar yield with an average 2.2, 6.8, 4.7 and 41.1%, respectively as compared with uninoculated treatment. All fungal treatments significantly increased in quality characters in root juice of sugarbeet compared with the check (nematode alone) and untreated treatments. The highest increase in percent of T.S.S., sucrose and purity as well as sugar yield (10.9, 19.2, 7.6 and 185.7%, respectively) compared with the check treatment (nematode alone) was obtained by the treatment of *V. chlamydosporium* fungus followed by *A. niger* (with an average 9.8, 16.4, 6.2, 165.0%, respectively) and *T. harzianum* (7.6, 11.0, 3.2 and 149.8%, respectively). However, the treatments with *P. nigricans* and *T. viride* gave a less increase in quality characters of juice sugarbeet roots.

From the previous results, it could be noticed that inoculation of sugarbeet with *V. chlamydosporium, A. niger* and *T. harzianum* showed better enhancement in plant growth (in terms of root, foliage and plant weight as well as length and diameter of root) and quality of root juice (in terms of T.S.S., sucrose and purity percentages) as well as sugar yield. These results support the findings reported by Windham *et al.* (1989) they reported that the major effect of the *Trichoderma* treatments sustained better plant growth enhancement to maize plants, whatever were infected with *M. arenaria* or not. Also, Amin and

Mostafa (2000) found that *Trichoderma* infested soils with *M. incognita* enhanced sunflower plant growth and yield in terms of disc weight. On the other hand, Maareg and Badr (2000) reported that the application of *A. niger* and *T. viride* treatments gave more promising results in terms of foliage and root growth as well as sugar yield of sugarbeet plants infected with *M. javanica* than that treated with nematode alone.

Table (14): Effect of six soil fungi on quality characters of sugarbeet plants as influenced by infection of *Meloidogyne incognita*.

Treatments	Total soluble solids (T.S.S)		Sucrose		Purity		Sugar yield Per plant	
	%	Incr-ease (%)	%	Incr-ease (%)	%	Incr-ease (%)	gm	%
M.i. only (check)	18.4	0.0	14.6	0.0	79.3	0.0	34.3	0.0
Untreated	18.8	2.2	15.6	6.8	83.0	4.7	48.4	41.1
M.i. + A.f.	19.4	5.4	15.8	8.2	81.2	2.4	82.6	140.8
M.i. + A.n.	20.2	9.8	17.0	16.4	84.2	6.2	91.0	165.3
M.i. + P.n.	18.6	1.1	15.4	5.5	82.8	4.4	79.0	130.3
M.i. + T.h.	19.8	7.6	16.2	11.0	81.8	3.2	85.5	149.3
M.i. + T.v.	19.0	3.3	15.4	5.5	81.1	2.3	77.6	126.2
M.i. + V.c.	20.4	10.9	17.4	19.2	85.3	7.6	98.0	185.7
L.S.D. 0.05	1.17		0.59		3.60		3.42	
0.01	1.63		0.81		5.00		4.75	

Mi=*Meloidogyne incognita* A.f. = *Aspergillus flavus*,
A.n. = *Aspergillus niger* P.n. = *Penecillium nigricans*
T.h. = *Trichoderma harzianum* T.v. = *Trichoderma viride*
V.c. = *Verticillium chlamydosporium*

4.2.2. Soil bacteria :

4.2.2.1. Laboratory bioassay test :

The toxicity of *Arthrobacter sp., Bacillus cereus, B. subtilis, Corynebacterium sp., Pseudomonas fluorescens, Serratia odorifera* and *Streptomyces sp.* culture filtrates against the juveniles larvae of *M. incognita* was studied in aqueous suspensions under laboratory conditions. During the exposure time, the juvenile larvae of *M. incognita* were subjected to a type of the bacterial filtrate tested. The filtrate activity was assessed by counting the number of living nematode larvae after 48 hours of the treatment. Percent mortality of each tested filtrate was calculated and corrected according to Abbot's formula (1925).

The results in Table (15) indicate that the seven bacterial species were effective against *M. incognita* juvenile larvae comparing with untreated control. Bacterial filtrates gave mortality percentage ranged between 45- 59%. The highest percentage mortality (59%) was obtained by the filtrate of *Serratia odorifera*, while the lowest percentage mortality (45%) was obtained by filtrate of *Arthrobacter sp.* However, the other tested bacterial filtrates gave comparatively pronounced percentage mortality of *M. incognita* juvenile larvae. In general, the toxicity of bacterial filtrates tested against *M. incognita* juvenile larvae could be arranged in a descending order as follows:

Serratia odorifera, Streptomyces sp., Pseudomonas fluorescens, Bacillus cereus, Corynebacterium sp., Bacillus subtilis and *Arthrobacter sp.*

Table (15): Percentage mortality of *Meloidogyne incognita* juveniles larvae treated with seven soil bacterial filtrates in laboratory bioassay test.

The tested bacterial filtrates	Mortality (%)
Arthrobacter sp.	45
Bacillus cereus	54
Bacillus subtilis	46
Corynebacterium sp.	47
Pseudomonas fluorescens	55
Serratia odorifera	59
Streptomyces sp.	57
L.S.D. 0.05 0.01	2.18 2.96

In short, it appears from the results that the bacterial filtrates of *B. cereus, S. odorifera, P. fulorescens* and *Streptomyces sp.* were the most effective filtrates. These filtrates occurred mortality percentage more than 50%, while the other bacterial filtrates recorded less than 50%. Similarly, El-Sherif *et al.* (1994) found that the culture filtrates of soil bacterial isolated, *Bacillus sp., Serratia sp. and Streptomyces sp.* inhibited of hatching of *M. incognita* eggs and highly toxic to juveniles of *M. incognita, Rotylenchulus reniformis* and *Tylenchulus semipenetrans* in laboratory. Also, Abdel-Rahman (1999 b)

reported that filtrates of soil bacterial isolates, *S. odorifera* and *B. cereus* displayed a high nematicidal activity on *M. incognita* juveniles larvae in bioassay test.

4.2.2.2. Greenhouse test :

The efficacy of four selected bacteria species (*B. cereus, S. odorifera, P. fluorescens* and *Streptomyces sp.*) in controlling the root-knot nematode, *M. incognita* infecting sugarbeet, and in improving the plant growth and its quality was studied under greenhouse conditions.

Data concerning the effect of the bacterial isolates on galls number, development and reproduction rates of *M. incognita* are shown in Table (16). It is worthy to notice that all the tested bacterial species succeeded, significantly, in controlling the nematode.

Gall formation was obviously reduced by using the bacterial organisms. The efficacy of these organisms differed according to the bacterial species. The percentage of reduction in gall numbers exceeded 50% in treatments of *S. odorifera, P. fluorescens* and *Streptomyces sp.* The highest percentage of reduction (56.3%) was achieved due to utilizing *S. odorifera*, while the lowest reduction percentage (47.3%) was achieved by *B. cereus*. However, the *P. fluorescens* and *Streptomyces sp.* caused 52.7 and 54.2% reduction in number of galls, respectively.

Concerning number of females produced in root system, statistically significant differences were not observed among treatments. The bacterium species, *P. fluorescens* showed maximum females reduction in *M. incognita* infection (50%). *S.*

odorifera, caused 47% females reduction and *Streptomyces sp.* with 45% reduction. However, the minimum percentage of reduction (43%) in females' number was recorded with *B. cereus*.

Nematode egg-masses number was significantly suppressed by all treatments, which varied greatly amongst the tested bacterial species. The bacterium species, *Streptomyces sp.* gave better results than the other ones. The highest percentage of reduction was obtained from the application of *Streptomyces sp.* (87.4%) followed by *S. odorifera* (79.9%) and *P. fluorescens* (77.3%) then *B. cereus* (66.4%).

Similar results were also noticed with reproduction rate on the root system of sugarbeet plants infected with *M. incognita*. Application of *Streptomyces* species showed highest percentage of reduction (87.4%) in reproduction rate followed by *S. odorifera* (79%) and *P. fluorescens* (77.3%), then *B. cereus* (66.4%). Statistically significant differences were observed among the treatments.

Juvenile larvae per 100 ml soil were significantly suppressed by all treatments. Maximum reduction (56.9%) in population of juvenile larvae per 100 ml soil was observed with *S. odorifera* followed by *Streptomyces sp.* (54.3%), *P. fluorescens* (52.7%) and *B. cereus* (47.7%).

Table (16): Effect of four selected soil bacteria on controlling *Meloidogyne incognita* infecting sugarbeet plants.

Treatments	Galls		Females		Egg-masses		Juveniles		Reproduction	
	No. per root	Reduction (%)	No. per root	Reduction (%)	No. per root	Reduction (%)	No./100 ml soil	Reduction (%)	Rate	Reduction (%)
M.i. alone (check)	112	0.0	100	0.0	119	0.0	1565	0.0	54.3	0.0
M.i. + *Bacillus cereus*	59	47.3	57	43	40	66.4	819	47.7	44.2	24.1
M.i+*Pseudomonas fluorescens*	53	52.7	50	50	27	77.3	740	52.7	35.1	35.4
M.i. + *Serratia odorifera*	49	56.3	53	47	25	79.0	675	56.9	32.1	40.9
M.i. + *Streptomyces sp.*	51	54.2	55	45	15	87.4	715	54.3	21.4	60.6
L.S.D. 0.05	2.00		N.S		1.79		38.7		1.86	
0.01	2.75		N.S		2.47		53.4		2.57	

In conclusion, some of the tested soil bacteria (*B. cereus, S. odorifera. P. fluorescens* and *Streptomyces species*) demonstrated nematicidal activities. Since they caused relatively high mortality rate to the tested juvenile larvae of *M. incognita*. These results support the findings reported by Lizuka *et al.* (1962) they reported that members of the bacterial genus *Serratia* have received attention as potential bio-control agents against nematodes. El-Sherif *et al.* (1994) found that bacterial isolates, *Bacillus sp., Crynebacterium sp., Serratia sp., Arthrobacterium sp.* and *Streptomyces sp.* gave satisfactory results when tested against *M. incognita* and *Rotylenchulus reniformis* on sunflower under screen-house conditions. Also, Ali and Kamal (1998) reported that bacterial isolates, *Serratia marcessens* and *Strptomyces avermitilis* achieved the best *M. incognita* nematode control on table grape under greenhouse and field conditions.

Strptomyces avermitilis achieved the best *M. incognita* nematode control on table grape under greenhouse and field conditions.

The *results* of the effect of the tested species of soil bacteria on sugarbeet growth, measured as root length, root diameter, root weight, foliage weight and plant weight are reported in Table (17). The results indicate that the inoculation with *M. incognita* resulted in reduction in root weight of 24%, foliage weight of 35.2%, plant weight of 28.6%, and root length of 24% and root diameter of 15.5% as compared with uninoculated treatment. Controlling of the root-knot nematode, *M. incognita* using soil bacterial species induced an increase in growth of sugarbeet plants ranged between 35.8-72.7% in root weight, 48.0-114.5% in foliage weight, 40.8-89.9% in plant weight, 23.7-32.0% in root length and root diameter as compared with the check (nematode alone).

The bacterium species, *S. odorifera* was ranked the first in increasing as length and diameter of root (32.0% for both), weight of root (72.7%), foliage (114.5%0) and plant (89.9%) as well, followed by *B. cereus* and *P. fluorscens* then *Streptomyces sp.*, bacterial species.

Table (17): Effect of four selected soil bacteria on the growth parameters of sugarbeet plants as influenced by infection of *Meloidogyne incognita*.

Treatments	Root length		Root diameter		Root weight		Foliage weight		Plant weight	
	cm	Increase (%)	cm	Increase (%)	gm	Increase (%)	gm	Increase (%)	gm	Increase (%)
M.i. only	21.9	0.0	9.7	0.0	235.0	0.0	163.0	0.0	389.9	0.0
Untreated	23.0	5.0	10.9	12.4	377.5	60.6	205.0	30.9	582.5	49.3
M.i. + *Bacillus cereus*	28.2	28.8	12.6	29.9	703.5	76.4	399.7	70.1	303.8	85.4
M.i+*Pseudomonas fluorescens*	28.1	28.3	12.5	28.9	634.5	59.1	349.1	48.6	285.4	74.1
M.i.+*Serratia odorifera*	28.9	32.0	12.8	32.0	757.4	89.9	405.9	72.7	351.5	114.5
M.i. + *Streptomyces sp.*	27.1	23.7	12.0	23.7	561.7	40.8	319.1	35.8	242.6	48.0
L.S.D. 0.05	1.75		0.95		58.0		35.4		41.7	
0.01	2.41		1.30		79.5		48.6		63.9	

The influence of tested soil bacteria on quality characters, i.e. total soluble solids (T.S.S.), sucrose and purity percentages in juice of sugarbeet roots in presence and absence of *M. incognita* nematode is shown in Table (18).

The data show that the inoculation with *M. incognita* induced a reduction in percent of T.S.S., sucrose and juice purity as well as sugar yield with an average 2.2, 6.8, 4.7 and 41.1%, respectively as compared with uninoculated treatment. The addition of tested soil bacterial species to soil resulted in more increase in percent of T.S.S., sucrose and purity in juice of sugarbeet roots and sugar yield by 18.5, 28.8, 8.7 and 122.4%, respectively for *S. odorifera* followed by 15.2, 24.7, 8.2 and 112.0%, respectively for *B. cereus* and 14.1, 21.9, 7.6 and 81.0%, respectively for *P. fluorescens*, then 10.9, 19.2, 6.9 and 61.8%, respectively for *Streptomyces sp.*, than the check treatment (nematode alone).

Shortly, the best results for growth parameters and quality as well as sugar yield of sugarbeet were obtained in pots receiving *S. odorifera*.

Table (18): Effect of four selected soil bacteria on quality characters of sugarbeet plants as influenced by infection of *Meloidogyne incognita*.

Treatments (concentration)	Total soluble solids (T.S.S)		Sucrose		Purity		Sugar yield Per plant	
	%	Incr-ease (%)	%	Incr-ease (%)	%	Incr-ease (%)	gm	Incr-ease (%)
M.i. alone (check)	18.4	0.0	14.6	0.0	79.3	0.0	34.3	0.0
Untreated	18.8	2.2	15.6	6.8	83.0	4.7	48.4	41.1
M.i. + *Bacillus cereus*	21.1	15.2	18.2	24.7	85.8	8.2	72.7	112.0
M.i+*Pseudomonas fluorescens*	21.0	14.1	17.8	21.9	85.3	7.6	62.1	81.0
M.i. + *Serratia odorifera*	21.8	18.5	18.8	28.8	86.2	8.7	76.3	122.4
M.i. + *Streptomyces sp.*	20.4	10.9	17.4	19.2	84.6	6.9	55.5	61.8
L.S.D. 0.05 0.01	1.32 1.81		0.57 0.83		0.99 1.35		1.11 1.52	

Similarly, Ali and Kamal (1998) found that application of bacterial isolates, *Serratia marcessens* and *Streptomyces avermitilis* achieved the best *M. incognita* control on table grape and improved plant growth as well as yield under greenhouse and field conditions when compared with those of the check.

4.3. Effects of soil mites on *Meloidogyne incognita* population and growth response of sugarbeet root:

4.3.1. Laboratory test :

Seven predacious soil mites extracted from sugareet fields at Ten thousand faddans area, West of Nubaryia were evaluated to their predacious activity on immature stages of *M. incignita* under laboratory conditions. The tested soil mites namely, *Amblyseius messor* (Wainstein), *Cheyletus molaccensis* (Coudemans), *Cumaxa sp.*, *Glycyphagus domesticus* (De Geer), *Macrocheles monchaolska* (B et K), *Platyseius major* (Halbert) and *Uropoda misella* (Berlese).

The data in Table (19) reveale that all tested soil mites (except *Cumaxa sp.*) fed on immature stages of *M. incognita*. These mites could be classified into three groups according the prey type, three mites, *A. messor* (Wainstein), *C. molaccensis* (Oudemans) and *P. major* (Halbert) were found to be predators on juvenile larvae stage. One mite was a predator on egg-masses stage and two mites were predators on both juvenile larvae and egg-masses stages.

The highest predation rate on juvenile larvae (4.27 ± 1.62 juvenile larvae/day/mite) was achieved by *C. molaccensis* (Oudemans) followed by *P. major* (Halbert) (3.90 ± 0.88), then by *A. messor* (Wainstein) (3.40 ± 1.07). However, the mite, *M. monchaolska* (B et K) was ranked the first in predation of both juvenile larvae and egg-masses (4.80 ± 1.03 larvae and 12.60 ± 1.26 eggs/day/mite, respectively) followed by *U. misella* (Berlese) (1.80 ± 0.79 larvae and 5.30 ± 1.16 eggs/day/mite).

Table (19): Average number of larvae and/or egg-masses of *Meloidogyne incognita* stage preyed by seven soil mites in laboratory assay test.

Tested soil mites	Predacious activity as average No. ± S.D. of consumed preys/day/an adult female	
	Egg stage	Second stage juvenile larvae (j2)
Amblyseius messor	0.00 ± 0.00	3.40 ± 1.07
Cheyletus malaccensis	0.00 ± 0.00	4.27 ± 1.62
Cumaxa sp.	0.00 ± 0.00	0.00 ± 0.00
Glycyphagus domesticus	4.90 ± 0.88	0.00 ± 0.00
Macrocheles monchaolska	12.6 ± 1.26	4.80 ± 1.03
Platyseius major	0.00 ± 0.00	3.90 ± 0.88
Uropoda misella	5.30 ± 1.16	1.80 ± 0.79

4.3.2. greenhouse test:

The effect of two selected predacious soil mites, separately and their mixture on population of the root-knot nematode, *M. incognita* infecting sugarbeet roots tabulated in Table (20). The results indicate that all treatments resulted in a significant reduction in number of galls, larvae, females and egg-masses/root and juvenile larvae in soil compared with the check treatment (nematode alone). Also, addition of *M. monchaolska* mite showed better reduction in these damage parameters of galls (62.5%), larvae (48.0%), females (74.8%) and egg-masses (62.3%) numbers/root and juvenile larvae in soil/pot as related to reduction percentage of these parameters were achieved with the mite, *C. malaccensis* (48.2, 29.9, 64.0 and 47.2% in number of galls, larvae, females and egg-masses/root and juvenile larvae in soil/pot, respectively). Treatment of a mixed together soil mites resulted in a significant reduction in all damage parameters of galls, larvae, females and egg-masses numbers/root and juvenile larvae in soil/pot compared with *C. malaccensis* mite treatment. However, the same mixed treatment achieved a very high reduction only in larvae and females/root and juvenile larvae in soil/pot compared with the other mite, *M. monchaolska*.

Extracted mite/pot was significantly increased in all treatments, which varied greatly amongst the tested mites. The highest increase percent was obtained in *C. malaccensis* mite (51.3%) followed (20.0%) in numbers of *M. monchaolska* mite. However, the least increase in numbers of both mites reduced with mixed together treatment.

Concerning reproduction index followed the same trend in result of extracted mite. Whereas, the highest value of reproduction index (1.51) recorded with *C. malaccensis* treatment and the lowest value (1.1) obtained by mixed two mites treatment.

The highest root weight (75.0%) was obtained by treatment of mixed together mites followed by *M. monchaolska* (71.8%), then *C. malaccensis* treatment (40.0%), without significant difference between *M. monchaolska* and *M. monchaolska* plus *C. malaccensis* treatments.

Several authors reported on small scale, pot experiment which indicated that mites brought about considerable reduction in nematode numbers. Sharma (1971) showed that *Lasioseius penecilliger* (Berlese) reduced the population of plant parasitic nematode by 44%, *Hypoaspis aculeifer* (Canestrini) by 68% and *Rhodacarus roseus* (Oudemans) by 85%. Mankau (1983) found that the mite, *Lasioseius scapulatus* (Kennett) was a predator on most plant parasitic nematode in laboratory. Maareg (1984) found that the *Macrocheles muscaedomesticae* mite caused higher reduction on gall number of *M. javanica* nematode than *Fuscuropoda vegetans* singly and in mixed together. Sell (1988) reported that the numbers of genus Caloglyphus mite predate on, larvae, females and egg-masses of the root-knot nematode, *Meloidogyne spp.* Walia and Mathur (1995) found that *Tyrophagus putrescentiae* and *Hypoaspis calcuttansis* mites fed on larvae and eggs of *M. javanica.* Also, Mostafa *et al.* (1997) found that significant reduction in *M. javanica* in soil, root galls and egg-masses numbers and improved tomato growth were

achieved with addition of *Tyrophagus putrescentiae* and *Hypoaspis calcuttansis* mites.

Table (20): The relationship between two selected predacious soil mites and *Meloidogyne incognita* infecting sugarbeet root in pot trial.

Treatments	Galls per root		Nematode stages/ root: Larvae		Female		Egg-masses		Juvenil larvae / plot		Final No. of mite / plot		Reproduction index of mite	Root weight	
	No.	red. %	No.	red. %	No.	red. %	No.	red. %	No.	red. %	No.	incr.%		gm.	incr. %
M. incognita only	51.0	0.0	127.0	0.0	139.0	0.0	53.0	0.0	189.0	0.0	0.0	0.0	0.0	28.0	
Cm + Mi	26.4	48.2	89.0	29.9	50.0	64	20.0	47.2	97.0	48.7	121.0	51.3	1.51	39.2	40.0
Mm + Mi	19.1	62.5	66.0	48.0	35.0	74.8	28.0	62.3	72.0	61.9	96.0	20.0	1.2	48.1	71.8
Cm+Mm+Mi	19.1	62.5	69.0	45.7	25.0	82.0	19.0	64.2	67.0	64.6	88.0	10.0	1.1	49.0	75.0
L.S.D. 0.05	0.80		4.30		2.62		1.75		3.57		2.69		0.08	2.86	
L.S.D. 0.01	1.07		5.76		3.51		2.34		4.78		3.60		0.11	3.83	

C m = *Cheyletus malaccensis* M m = *Macrocheles monchaolska*

5. Interrelationship among the plant parasitic nematode, *Meloidogyne incognita*, nemtophagous fungus, *Arthrobotrys conoides* and predator nematode *Diplogaster sp.* in the rhizosphere of sugaebeet plants:

5.1. Population dynamic of *Arthrobotrys conoides* with or without *Diplogaster sp.* or *Meloidogyne incognita*:

The data in Table (21) and Figure (6) indicate the log number of population dynamic of the nematophagous fungus, *A. conoides* alone in the rhizosphere of sugarbeet, significantly decreased by 4.95, 9.48, 12.37, 16.49, 20.62 and 23.51 % during 2, 4, 6, 8, 10 and 12 week of inoculation, respectively, compared with initial population. *A. conoides* affected the two nematode species in the rhizosphere differently, predator nematode species, *Diplogaster sp.* significantly increased the population of *A. conoides* during the first 2 weeks of inoculation, then progressively decreased during the following periods till the 12th week of inoculation. The decreased percentages were 2.17, 3.04, 3.47 and 4.34 % during the 4, 6, 8, 10 and 12 week respectively. However, *A. conoides* population decreased in the presence of plant parasitic nematode, *M. incognita* during the first 2 weeks of inoculation, but there was no significant. After the first 2 weeks of inoculation population density of *A. concoides* significantly increased during the second 2 weeks, and gradually decreased from the third 2 weeks till the end the 12th week after inoculation.

Generally, nematophagous fungus, *A. conoides*, significantly increased in the presence of *Diplogaster sp.* or *M.*

incognita by 18.9 or 24.0 %, respectively in the rhizosphere of sugarbeet compared with *A. conoides* alone.

Table (21): Population dynamics of the nematophagous fungus *Arthrobotrys conoides* (Ac) with or without predator nematodes *Diplogaster sp.* (D) or plant parasitic nematode, *Meloidogyne incognita* (Mi) in the rhizosphere of sugarbeet plants.

Treatments	Weeks after inoculation							
	* Pi	2	4	6	8	10	12	L.S.D. 0.05
Ac	4.85	4.61	4.39	4.25	4.05	3.83	3.71	0.01
Ac + D	4.54	4.61	4.51	4.47	4.45	4.43	4.41	0.07
Ac + Mi	4.71	4.65	4.77	4.69	4.65	4.63	4.60	0.07
L.S.D. 0.05							0.06	

*Pi = initial population of *A. conoides* as log number of comparison

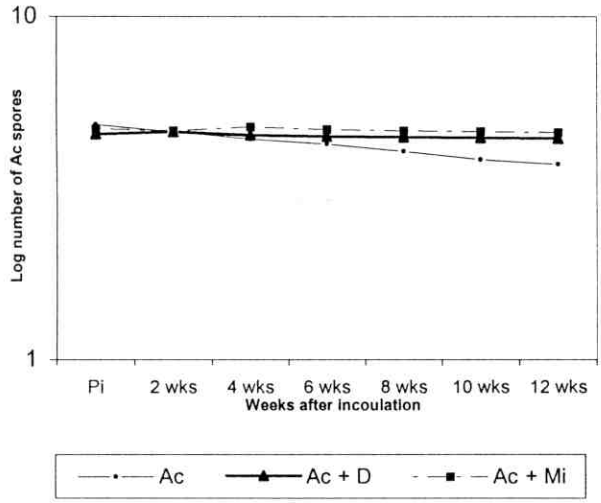


Figure (6): Population dynamics of the nematophagous fungus *Arthrobotrys conoides* (Ac) with or without predator nematode, *Diplogaster sp.* (D) or plant parasitic nematode, *Meloidogyne incognita* (Mi) in the rhizosphere of sugarbeet plants.

5.2. Population dynamic of *Diplogaster sp.* with or without *Arthrobotrys conoides* or *Meloidogyne incognita*:

The log number of population dynamic of predator nematode, *Diplogaster sp.* with and without nematophagous fungus, *A. conoides* or plant parasitic nematode, *M. incognita* presented in Table (22) , the data showed that the population log number of *Diplogaster sp.* alone, significantly increased from 1.57 to 2.15 in the first 6 weeks period and significantly decreased to 1.94 in the following 6 weeks period in sugarbeet

rhizosphere. Addition of nematophagous fungus, *A. conoides* to the soil significantly increased the population density of *Diplogaster sp.* during the first 2 weeks of inoculation and gradually decreased till the end of 12 week. In contrary, the population density of predator nematode, *Diplogaster sp.* significantly increased in the presence of plant parasitic nematode, *M. incognita* during the period of study in the rhizosphere. The increase percentage was 8.54, 20.73, 33.54, 40.24, 44.51 and 48.78 % as compared to initial population during the periods of 2, 4, 6, 8, 10 and 12 weeks, respectively.

The data also, revealed that *Diplogaster sp.* significantly decreased in the presence of *A. conoides* by (23.7 %) and significantly increased in the presence of *M. incognita* by (25.8 %) in the rhizosphere compared with density of *Diplogaster sp.* alone.

Table (22): Population dynamics of predator nematode, *Diplogaster sp.* (D) with or without nematophagous fungus, *Arthrobotrys conoides* (Ac) or plant parasitic nematode, *Meloidogyne incognita* (Mi) in the rhizosphere of sugarbeet plants.

Treatments	Weeks after inoculation							
	* Pi	2	4	6	8	10	12	L.S.D. 0.05
D	1.57	1.60	1.94	2.15	2.05	1.99	1.94	0.10
D + Ac	1.64	1.84	1.66	1.59	1.55	1.51	1.48	0.08
D + Mi	1.64	1.78	1.98	2.19	2.30	2.37	2.44	0.10
L.S.D. 0.05							0.18	

* Pi = initial population of *Diplogaster sp* as log number.

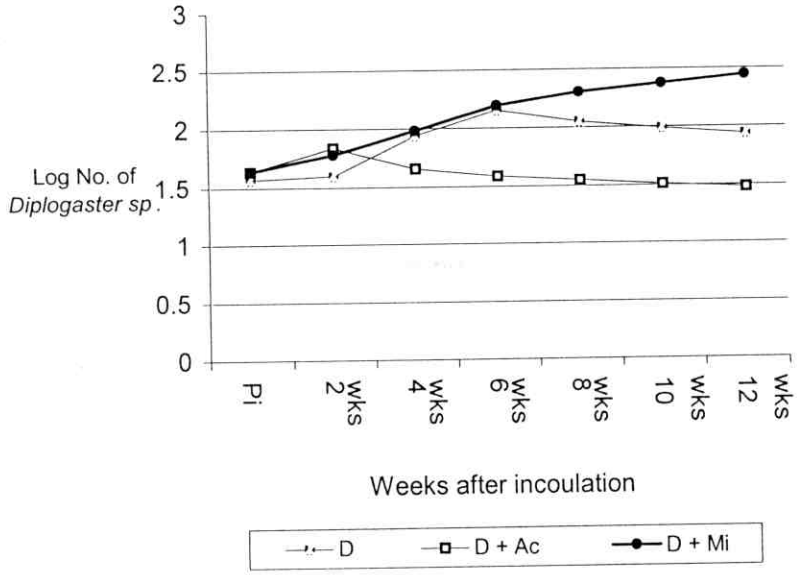


Figure (7): Population dynamics of predator nematode, *Diplogaster sp.* (D) with or without nematophagous fungus, *Arthrobotrys conoides* (Ac) or plant parasitic nematode, *Meloidogyne incognita* (Mi) in the rhizosphere of sugarbeet plants.

5.3. Population dynamic of *Meloidogyne incognita* with or without *A. conoides* or *Diplogaster sp.* :

The results 'effect of nematophagous fungus, *A. conoides* and predator nematode, *Diplogaster sp.* on population dynamic of plant parasitic nematode, *M.* incognita in the rhizosphere of sugarbeet tabulated in Table (23). The results indicated that *M. incognita* population density affected nematophagous fungus and predator nematode species. The fungus, *A. conoides* significantly increased the population as log number of *M. incognita* during the first 2 weeks of inoculation. After this period, log number of

M. incognita population significantly decreased during the other experiment periods (the rest of experiment period), with an average of reduction percentage of 3.77, 5.66, 37.74, 71.07 and 77.99 % during the periods of 4, 6, 8, 10 and 12 week, respectively compared with initial population.

Also, *M. incognita* population density as log number increased in the presence of *Diplogaster sp.* throughout the first 2 weeks period of inoculation. Then, the log number of population significantly decreased in the following 4, 6, 8, 10 and 12 week periods. The decrease percentages were, 5.10, 30.57, 36.31, 36.94 and 44.59 % compared to initial population log number during the above mentioned periods.

In general, the results showed that nematophagous fungus, *A. conoides* significantly suppressed the development of plant parasitic nematode, *M. incognita* (by 94.90 %) than predator nematode, *Diplogaster sp.* (by 87.60 %) in the rhizosphere of sugarbeet plants.

Apparently, trophic inetractions occurred in rhizosphere of sugarbeet during the experimental period (Tables, 21, 22 and 23; and Figure 6, 7, and 8). The two nematode species affected nematophagous fungus , *A. conoides*. The density of *A. conoides* significantly increased in the presence of predator nematode, *Diplogaster sp.* or *M. incognita* species by 18.9 or 24.0 %, respectively. In turn, *A. conoides* significantly suppressed the development of plant parasitic nematode, *M. incognita* by 94.7 % and significantly decreased population density of *Diplogaster sp.* by 23.7 %. Development of *A. conoides* was more abundantly in presence of the plant parasitic nematode, *M. incognita* than

predator nematode, *Diplogaster sp.* in the rhizosphere of sugarbeet plants. Also, in the presence of the two nematodes in the rhizosphere, *Diplogaster sp.* species significantly increased by 25.8 %, while, *M. incognita* species significantly decreased by 87.0%.

Table (23): Population dynamics of plant parasitic nematode, *Meloidogyne incognita* (Mi) with or without nematophagous fungus *Arthrobotrys conoides* (Ac) or predator nematode, *Diplogaster sp.* (D)) in the rhizosphere of sugarbeet plants.

Treatments	Weeks after inoculation							
	* Pi	** 2	4	6	8	10	12	L.S.D. 0.05
Mi	1.43	1.40	1.56	2.86	3.98	4.84	6.86	0.08
Mi + Ac	1.57	1.59	1.53	1.50	0.99	0.46	0.35	0.08
Mi + D	1.57	1.60	1.49	1.09	1.00	0.99	0.87	0.09
L.S.D. 0.05							0.21	

* Pi = initial population of *M. incognita* as per thousand of larvae.

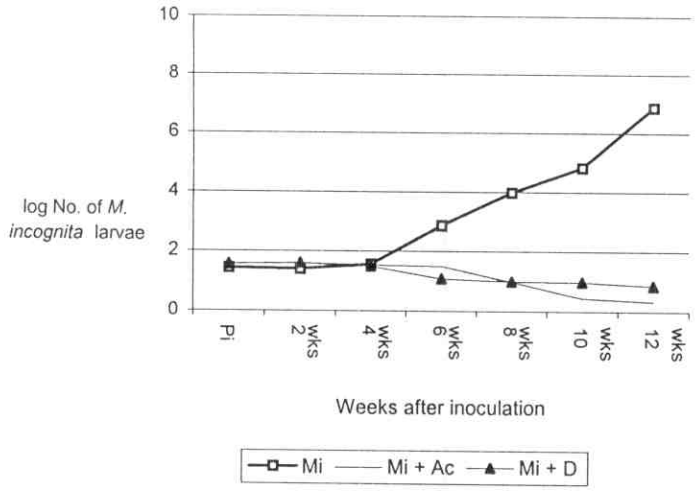


Figure (8): Population dynamics of the plant parasitic nematode, *Meloidogyne incognita* (Mi) with or without nematophagous fungus *Arthrobotrys conoides* (Ac) or predator nematode, *Diplogaster sp.* (D)) in the rhizosphere of sugarbeet plants.

6. Evaluation of some animal manures for mass production of some nematophagous fungi and related effects on *Meloidogyne incognita* infecting sugarbeet plants:

Grain of wheat (Jatola, 1981), rice (Shahzad and Ghaffor, 1989), Oat (Kerry *et al.*, 1984) alginate pellets (Cabanillas *et al.*, 1989) and other media have been used to propagate fungi for their additions to soil. The used cereal garins for mass production of fungi for nematode control might not be practical because of the need for cereals for human consumption, there is a need to search for other substrates for mass production of fungi. Animal manures are sheep, universally available substrates and commonly used in agriculture as fertilizers. To best of our knowledge, there is no use of animal manure in the mass production of fungi is available. In this study we evaluated different animal manures, e.g. broiler chicken, layer chicken, cow and sheep manures and a fermented mix of these (compost) as a substrate for fungal propagation and compared with wheat grain as a substrate medium.

The total nitrogen, carbon, potassium and phosphorus contents as well as pH value of the wheat grains and broiler chicken, layer chicken, sheep, cow and compost manures used as a substrate for evaluation of fungal growth were determined and tabulated in Table (24). The highest value of total nitrogen content was recorded with broiler and layer chicken manures (3.97 and 3.95 %, respectively) followed by cow manure (2.49 %), wheat grains (2.36 %), sheep manure (1.87 %) and compost

manure gave the lowest value (1.68 %). Carbon content recorded the highest percentage with wheat grains and sheep manure (46.6 and 42.6 %, respectively). Moderate to total carbon values were noticed with broiler chicken (32.1 %), layer chicken (32.1 %) and cow (30.2 %) manures and the lowest value (15.2 %) was with compost manure. Also, the highest value of C/N ratio was found with sheep manure (22.8) and wheat grains (19.7) followed by cow (12.1) and compost (9.0) manures, however, the lowest value was recorded with both broiler and layer chicken manures (8.1). The maximum value of potassium content was observed with sheep manure followed by compost, broiler chicken and layer chicken manures, and then cow manure and wheat grains. Whereas, phosphorus content was 1.71, 1.72, 4.19, 0.37, 1.27 and 0.36 % for broiler chicken, layer chicken, compost, cow and sheep manures as well as wheat grain, respectively. The results also, indicated that pH values of broiler and layer chickens and wheat grains were in the acidity range (6.4 – 6.6), however, the pH values of compost, cow and sheep manures were in the alkaline range (7.6 – 7.8).

Table (24): Mineral content and pH of the substrates used for the evaluation of fungal growth.

Evaluated substrates	Total N %	Total C %	C/N	Total K%	Total P%	PH
Broiler manure	3.97	32.1	8.1	1.44	1.71	6.6
Compost	1.68	15.2	9.0	1.45	4.19	7.8
Cow manure	2.49	30.2	12.1	0.81	0.37	7.6
Layer manure	3.95	32.1	8.1	1.44	1.72	6.4
Sheep manure	1.87	42.6	22.8	2.15	1.27	7.7
Wheat grains	2.36	46.6	19.7	0.36	0.36	6.4

6.1. Laboratory test:

6.1.1. Fungal growth on substrates:

6.1.1.1. Mycelial growth:

Growth indices of six selected soil fungi *Aspergillus niger, Fusarium solani, Penicillium nigricans, Trichoderma harzianum, T. viride and Verticillium chlamydosporium* fungi on different animal manures, (broiler chicken, compost, cow, layer chicken and sheep manures) compost to wheat grain medium reported in Table (25). The results indicate that the greatest growth of *A. niger* (4.7) was observed on wheat grain medium, while the lowest growth (1.7) was found on compost manure. Generally the growth of *A. niger* fungus was abundant on wheat grains, moderate on broiler chicken, compost, cow and layer chicken manures and poor on sheep manure. Growth of *F. solani* was abundant on broiler chicken (4.7), compost (4.0) and layer chicken (4.7) manure and wheat grain medium (4.0) with no differences among the four substrates. Slightly but significantly lower growth was observed on the cow (3.7) and sheep (3.0) manures substrates. The growth of *P. nigricans* was greatest on wheat grain medium (5.0) and broiler chicken manures (4.7), which did not differ in their suitability as substrate. Moderate to growth indices were observed on cow and layer chicken manures (3.3 and 3.7, respectively) and poor growth on compost and sheep manures (2.7 and 2.3, respectively).

Growth of *T. harzianum* was abundant on wheat grain medium (4.3) and broiler chicken manure (4.0) followed by layer chicken (3.3) and cow manures (3.3). The compost (2.0) and sheep (2.3) manures were the less suitable for *T. harzianum*.

Growth of *T. viride* on broiler chicken, cow, compost, layer chicken and sheep manures was either greater than that observed on wheat grain. The growth of this fungus was abundant on, broiler chicken, cow and layer chicken manures, and moderate on both compost and sheep manures. However, *V. chlamydosporium* observed greater growth on broiler chicken, cow and layer chicken manures and wheat grain medium followed by sheep manure. Poor growth was observed on compost manure.

From the results, it could be concluded that growth of the three fungi, *F. solani, T. viride and V. chlamydosporium* on broiler chicken, layer chicken, cow or compost manures was greater than, or similar to, that observed on wheat grain medium (Table, 25).

Table (25): Mycelial growth indices* for six nematophagous fungi on different animal manures (as substrates) compared to wheat grain medium.

Investigated fungi	B.C.	COM	C.M	L.C	S.M.	W.G	L.S.D 0.05
Aspergillus niger	3.7	1.7	3.0	3.3	2.0	4.7	0.86
Fusarium solani	4.7	4.0	3.7	4.7	3.0	4.0	1.37
Penicillium nigricans	4.7	2.7	3.3	3.7	2.3	5.0	1.18
Trichoderma harzianum	4.0	2.0	3.3	3.3	2.3	4.3	1.37
Trichoderma viride	4.3	3.7	4.0	4.7	3.7	3.3	1.31
Verticillium chlamydosporium	5.0	2.7	4.7	4.3	3.3	5.0	0.88
mean	4.4	2.8	3.7	4.0	2.8	4.4	0.77
L.S.D. 0.05	1.15	1.09	1.11	1.01	1.31	1.00	

- Growth index used is
- 1 = No growth 2 = poor growth 3 = moderate growth, 4 = abundant growth 5 = very abundant growth.

B.C. = Broiler chicken manure C.M. = Cow manure COM. = Compost
L.C. = Layer chicken manure S.M. = Sheep manuer W.G. = Wheat grains

6.1.1.2.Sporoulation:

Number of spores produced of each of the six tested fungi per gram of different animal manures compared with wheat grain medium tabulated in Table (26). The data indicate that the sporoulation of *A. niger* fungus was much greater on wheat grain medium than on all animal manures used in this study (broiler chicken, cow, compost, layer chicken and sheep manures). Also, the data demonstrate that broiler chicken, cow and layer chicken manures were better alternative to wheat grains for the spores production of the fungi, *F. solani, T. harzianum and V. chlamydosporium*. Sporoulation of *T. viride* on broiler chicken, cow, layer chicken and sheep manures was either greater than that observed on wheat grain, except for its poorer sporoulation on compost manure. However, the fungi *P. nigricans* produced the highest numbers of spores only on broiler and layer chicken manures compared with wheat grain medium and the other animal manures used in this study.

Table (26): Spores number of six nematophagous fungi produced per gram weight of different animal manures compared to wheat grain medium.

Investigated fungi	Number of spores / gm $X10^7$						
	Broiler chicken	Compost	Cow manure	Layer chicken	Sheep manure	Wheat grain	L.S.D. 0.05
A. niger	25.5	14.8	24.3	21.4	11.5	42.7	6.55
F. solani	23.8	5.3	10.9	26.7	4.7	5.7	4.38
P. nigricans	33.7	2.7	17.8	27.1	5.3	21.3	5.61
T. harzianum	76.1	16.2	59.2	64.5	49.7	55.3	22.91
T. viride	46.4	11.9	44.1	50.7	39.3	35.6	12.60
V.chlamydosporium	95.5	53.0	87.1	76.7	41.1	64.3	14.70

In short, the present investigation demonstrated that broiler chicken, layer chicken and cow manures are better alternatives to wheat grain medium for the mass production of the fungi, *F. solani, T. harzianum and V. chlamydosporium*, however, the broiler and layer chicken manures only are for mass production of the fungus *P. nigricans.* Spore production of the five fungi, *F. solani, P. nigricans., T. harzianum, T. viride and V. chlamydosporium* on broiler chicken manure was 417.5, 156.3, 121.3, 130.3 and 148.5 %, respectively, whereas, it was 468.4, 78.6, 116.6, 142.4 and 119.3 % on layer chicken manure, respectively higher than on wheat grain medium. Sporulation of each of the four fungi, , *F. solani, T. harzianum, .T. viride and V. chlamydosporium* was much greater on cow manure than on wheat grain medium by 191.2, 107.1, 123.9 and 135.5 %, respectively.

It could be concluded that the spore production of these fungi on both chicken manures was 87.6 – 468.4 % and on cow manure was 107.1 – 191.2 % higher than on wheat grain medium. The variability in species of the fungi involved indicates a general suitability of these substrates for fungal production. Organic matter with a low C/N ratio resulted in a broad spectrum stimulation of the soil microflora (Rodriguez-Kabana *et al.*, 1987). The above mentioned manures had lower C/N ratio than wheat (Table, 24). On these substrates the fungi produced more spores than on wheat. These results agree with those reported by Abu-Laban and Saleh (1992) they found that spores production of *F. solani, F. oxysporium* and *P. lilacinus* on both chicken manures was 22 – 290 % higher than on wheat.

6.2.Greenhouse test:

Results in Table (27) show the efficiency of the three selected nematophagous fungi, *F. solani, T. viride* and *V. chlamydosporium* and their substrates "cow, broiler chicken and layer chicken manures as well as wheat grain medium" alone or the galls number per root system and colonized egg-masses percentage of *M. incognita* on sugarbeet greenhouse plant.

The results showed that all the tested carrier substrates were able to reduce number of galls per root system induced by *M. incognita* on sugarbeet plants as compared with check (nematode inoculum alone). Layer chicken manure as carrier substrate gave a significantly high degree in reducing number of galls per root system (26.1 %) followed by broiler chicken (21.7 %), cow (11.6 %) manures and wheat grains (6.1 %). Also, the results cleared that both broiler and layer chicken manures gave significantly reduction in the number of root galls of the plant parasitic nematode, *M. incognita* by 21.3 and 16.7, respectively, compared with wheat grains.

On cow, broiler chicken or layer chicken manures, the three tested nematophagous fungi reduced the number of galls more than on wheat grains. *F. solani* fungus only significantly reduced the number of galls when introduced on broiler or layer chicken manures. However, *T. viride and V. chlamydosporium* fungi significantly reduced the galls number when added on cow, broiler chicken or layer chicken manures, compared to influence on the nematode when added on wheat grains.

By using layer chicken manure as carrier substrate, the three tested nematophagous fungi were very effective in reducing

root galling on sugarbeet plants by *M. incognita* as compared with the other two substrate (cow and broiler manures).

The fungus, *F. solani* was less effective against the nematode when added on cow manure or wheat grains, while, the fungus, *V. chlamydosporium* was the most effective when added on layer chicken manure.

In short, on layer chicken manure as the best carrier substrate, *F. solani, T. viride and V. chlamydosporium* reduced sugarbeet galling caused by *M. incognita* by 80.6, 91.3 and 95.0 %, respectively compared with check. Also, the reduction percentage of the mentioned tested nematophagous fungi when added on both layer chicken and broiler chicken manures were (207.5 – 349.5 %) and (115.0 – 213.2 %), respectively higher than on wheat grains.

Concerning the colonization of egg masses, the results in Table, 27 reveale that the colonization of egg masses of *F. solani, T. viride and V. chlamydosporium* when added on broiler chicken, cow and layer chicken manures was either greater than or similar to that observed when added on wheat grains. On the other hand, the colonization of egg masses by the inoculation of fungi was greater when these were introduced on layer chicken manure than on the other two carrier substrates (cow and broiler chicken manures). By using layer chicken manure as carrier substrate, the fungus, *V. chlamydosporium* gave the highest colonized egg masses percentage followed by *T. viride* and *F. solani* gave the lowest percentage in this respect.

The same following of these fungi observed when these were added on either broiler chicken, cow manures or wheat

grains. On all tested substrates, the fungus, *V. chlamydosporium* gave a significantly high degree in percentages (with an average of 56.6, 35.5, 73.3 and 26.6 %) when added on broiler chicken, cow, layer chicken and wheat grain substrates, respectively. While *F. solani* gave a lower percentages in this respect. Generally, the highest percentage of colonized egg masses was obtained by *V. chlamydosporium* fungus when introduced on layer and broiler chicken manures (73.3 and 56.6 %, respectively). However, the lowest percentage was obtained by *F. solani* when added on cow manure or on wheat grains (2.0 % of both).

From the previous results, it could be noticed that the three mentioned nematophagous fungi were very effective in controlling nematode, *M. incognita* when added on layer chicken manures compared to their potential when added on wheat grains as carrier substrates. However, the fungus, *F. solani* was less effective against *M. incognita* when applicated on cow manure or on wheat grains. In similar study, Abu Laban and Saleh (1992) found that the fungus, *F. solani* reduced tomato galling caused by *M. javanica* and the number of galls when introduced on broiler chicken manure or on wheat grains through less efficiently.

Table (27): Effect of the three nematophagous fungi; *Fusarium solani*, *Trichoderma viride* and *Verticillium chlamydosporium* and their substrates alone on the root-knot nematode, *Meloidogyne incognita* in the greenhouse.

Treatment	Galls No. / root system		%
	Average No.	Reduction %	Colonized eggs
Nematode + broiler chicken manure inoculated with :			
F. solani	45.0	60.9	2.3
T. viride	23.0	80.0	5.0
V.chlamydosporium	18.3	84.1	56.6
Non (check)	85.0	26.1	--
Mean	42.8	62.8	11.33
Nematode + cow manure inoculated with :			
F. solani	55.7	51.6	2.0
T. viride	26.7	76.8	4.3
V.chlamydosporium	30.3	73.7	35.3
Non (check)	101.7	11.6	--
Mean	53.6	53.4	13.9
Nematode + layer chicken manure inoculated with :			
F. solani	22.3	80.6	4.7
T. viride	10.0	91.3	11.5
V.chlamydosporium	5.7	95.0	73.3
Non (check)	90.0	21.7	--
Mean	32.0	72.2	29.8
Nematode + wheat grain medium inoculated with :			
F. solani	62.7	45.5	2.0
T. viride	36.7	68.1	3.3
V.chlamydosporium	40.3	65.0	26.6
Non (check)	108.0	6.1	--
Mean	61.9	46.2	10.6
L.S.D. 0.05	4.2	--	1.09

L.S.D. 0.05 between fungi species for gall number / root

Carrier I	Carrier II	Carrier III	Carrier IV
4.9	10.1	15.3	13.5

L.S.D. 0.05 fungus X substrate for gall number / root

F. solani	7.28
T. viride	3.78
V. chlamydosporium	3.71

L.S.D. 0.05 between fungi species for % colonized eggs

Carrier I	Carrier II	Carrier III	Carrier IV
2..28	1.48	1.10	1.22

L.S.D. 0.05 fungus X substrate for % colonized eggs

F. solani	0.14
T. viride	0.32
V. chlamydosporium	2.63

In short, on layer chicken manure as the best carrier substrate, *F. solani, T. viride and V. chlamydosporium* reduced sugarbeet galling caused by *M. incognita* by 80.6, 91.3 and 95.0 %, respectively compared with check. Also, the reduction percentage of the mentioned tested nematophagous fungi when added on both layer chicken and broiler chicken manures were (207.5 – 349.5 %) and (115.0 – 213.2 %), respectively higher than on wheat grains.

Concerning the colonization of egg masses, the results in Table, 27 reveale that the colonization of egg masses of *F. solani, T. viride and V. chlamydosporium* when added on broiler chicken, cow and layer chicken manures was either greater than or similar to that observed when added on wheat grains. On the other hand, the colonization of egg masses by the inoculation of fungi was greater when these were introduced on layer chicken manure than on the other two carrier substrates (cow and broiler chicken manures). By using layer chicken manure as carrier substrate, the fungus, *V. chlamydosporium* gave the highest colonized egg masses percentage followed by *T. viride* and *F. solani* gave the lowest percentage in this respect. The same following of these fungi observed when these were added on either broiler chicken, cow manures or wheat grains. On all tested substrates, the fungus, *V. chlamydosporium* gave a significantly high degree in percentages (with an average of 56.6, 35.5, 73.3 and 26.6 %) when added on broiler chicken, cow, layer chicken and wheat grain substrates, respectively. While *F. solani* gave a lower percentages in this respect. Generally, the highest percentage of colonized egg masses was obtained by *V.*

chlamydosporium fungus when introduced on layer and broiler chicken manures (73.3 and 56.6 %, respectively). However, the lowest percentage was obtained by *F. solani* when added on cow manure or on wheat grains (2.0 % of both).

From the previous results, it could be noticed that the three mentioned nematophagous fungi were very effective in controlling nematode, *M. incognita* when added on layer chicken manures compared to their potential when added on wheat grains as carrier substrates. However, the fungus, *F. solani* was less effective against *M. incognita* when applicated on cow manure or on wheat grains. In similar study, Abu Laban and Saleh (1992) found that the fungus, *F. solani* reduced tomato galling caused by *M. javanica* and the number of galls when introduced on broiler chicken manure or on wheat grains through less efficiently.

7. Susceptibility of sugarbeet varieties to *Meloidogyne incognita* infection:

7.1. Field experiment:

Twenty- one sugarbeet varieties were tested for their susceptibility or resistance to the root-knot nematode, M. incognita under field conditions. Data in Table 28 revealed that significant differences (P= 0.05 and 0.01) were found in gall index (GI), gall size (GS) and gall area (GA).

The GI value ranged from 1.7-8.3. Marathon and Sultan varities having the lowest value of GI (1.7), however, Chems, Nejema, Helena and Mito verities having the highest values (8.3, 7.0, 6.3 and 6.0, respectively). The other varities, having moderate values of GI.

Concerning of GS, the varieties, Emma, Kawemira, Marathon and Sultan having the lowest value (1.7 for each) however, the varities Chems, Elan, Helena, Mito, and Nejema having the highest GS values (7.1, 7.0, 6.3, 6.9, 6.9).

Values of GA ranged from 1.7 (with each of Emma, Kawemira, Marathon and Sultan varieties) to 8.0 with Chems variety. The other varieties having moderate value.

Comparing sugarbeet varieties according to numbers of *M. incognita* egg-masses expressed as egg-masses index (EI), the data show significant differences (P= 0.05 and 0.01). The values of EI ranged generally from 2.7 for Baraka variety to 8.3 for Nejema. Eventually, the varieties Nejema, Elan, Helena, Mito and Del. 939 attained the highest EI values, with an average of 8.3, 7.7, 7.7, 7.3 and 7.0, respectively. However, Baraka, Kawemira, Emma, Marathon, Sultan and Tarios varieties had the lowest (EI) values with an average of 2.7, 2.3, 3.3, 3.0, 3.3 and 3.3, respectively (Table 28).

Categorization with the tested varieties according to the damage index (DI) of Sharma *et al.* (1994) is shown in the same Table. The DI categorized the varieties into four as resistant, eleven moderately resistant, four susceptible and two highly susceptible (Table,28). Emma, Kawemira, Marathon and Sultan varieties were resistant to *M. incognita* nematode. While, Baraka, Farida, Ivv Romano, Lados, Laser, Orio, M 9680, Av poly, M 9383, Ras poly and Tarios were moderately resistant. On the contrary, the sugarbeet varieties Helena, Mito, Elan and Del. 939 were considered susceptible, Chems and Nejema varieties were highly susceptible.

Table (28): Relative susceptibility of twenty-one sugarbeet varieties against *Meloidogyne incognita* infection under field conditions at the Ten-thousand faddans area, West Nubaryia region.

Investigated sugarbeet varieties	Gall index (GI)	Galled size index (GS)	Galled area index (GA)	Egg-masses index (EI)	Computed Damege index (DI)	Varieties reaction
Av poly	4.7	5.0	5.0	5.0	4.9	MR
Baraka	2.3	3.7	3.0	2.7	3.0	MR
Chema	8.3	7.1	8.0	5.7	7.8	HS
Del. 939	5.3	5.8	6.3	7.0	5.8	S
Elan	5.7	5.9	7.0	7.7	6.2	S
Emma	2.0	1.7	1.7	3.3	1.8	R
Farida	4.3	4.9	3.7	4.0	4.3	MR
Helena	6.3	6.3	5.7	7.7	6.1	S
IvvRomano	3.3	3.8	4.3	3.7	3.8	MR
Kawemira	2.3	1.7	1.7	2.3	1.9	R
Lados	2.7	3.8	3.7	3.7	3.4	MR
Laser	4.3	4.3	3.7	4.3	4.1	MR
M 9383	3.0	2.9	3.7	4.0	3.2	MR
M 9680	4.0	4.9	4.3	4.3	4.4	MR
Marathon	1.7	1.7	1.7	3.0	1.7	R
Mito	6.0	6.9	5.7	7.3	6.2	S
Nejema	7.0	6.9	7.7	8.3	7.2	HS
Orio	4.3	4.9	4.3	4.7	4.5	MR
Ras poly	3.3	4.4	4.3	3.7	4.0	MR
Sultan	1.7	1.7	1.7	3.3	1.7	R
Tarios	2.7	3.0	3.0	3.3	2.9	MR
L.S.D. 0.05	1.21	1.25	1.88	1.90	1.21	
0.01	1.63	1.65	2.16	2.54	1.61	

Table (29): Numbers of *Meloidogyne incognita* galls, developmental stages and total nematodes on root system of sugarbeet varieties as well as second-stage juveniles in soil.

Investigated sugarbeet varieties	Nematode stages in root system				No. of gall/root	Second stage juveniles In soil	Total final
	Immature stage	Mature females	Total stages	Egg-masses			
Emma	59	33	92	5	11	30	122
Kawemira	83	73	156	29	13	62	218
Marathon	93	85	178	13	12	49	227
Sultan	191	108	299	17	21	33	332
L.S.D. 0.05	9.70	9.63	9.42	4.51	5.57	4.55	88.02
0.01	14.11	14.01	13.71	6.57	8.11	6.63	128

7.2. Greenhouse experiment:

Four sugarbeet varieties namely Emma, Kawemira, Marathon and Sultan are considered resistant for the root-knot nematode, *M. incognita* under field conditions. These varieties were selected for confirm their resistance to artificial infection of this nematode pest under greenhouse condition. Data on number of galls, developmental stages and total nematodes on root system of sugarbeet varieties as well as second-stage larvae in soil/plant were recorded after 45 days from inoculation are shown in Table (29). The highest number of root galls, total nematode stages in root and egg-masses per root (21, 264, 29 per root, respectively) were attained as a result of infection with *M. incognita* on Sultan sugarbeet variety. Whereas, the lowest

number of galling, total nematode stages and egg-masses per root (5, 92 and 11 per root, respectively) were recorded on Emma sugarbeet variety with *M. incognita* infection. On the other hand, the other tested varieties, Kawemira and Marathon had nematode numbers.

The results in Table (29) also, indicate that Emma variety had the lowest final population with an average of 122 individual / plant of the root-knot nematode, *M. incognita,* while, Sultan variety had the highest final population (332 individual / plant). The other varieties, Kawemira and Marathon had moderate final population (253 and 227 individual / plant, respectively).

Statistical signification differences (P= 0.05 and 0.010) were found among the varieties concerning the numbers of galls, immature stages, mature females, egg-masses and final population as shown in Table (29).

The rates of penetration, reproduction, maturation and build-up of root-knot nematode, *M .incognita* were recorded in Table (30). Emma variety had a low rate of penetration (4.6), rate of reproduction (1.7), rate of build-up (6.1) for *M. incognita.* On the contrary, sultan showed to be the most susceptible variety. Its rates of penetration, reproduction, maturation and build-up were 13.2, 6.3 and 14.9, respectively. The other tested varieties (Kawemira and Marathon) had moderate rates.

Finally the evaluation studies of twenty-one varieties of sugarbeet for their susceptibility or resistance to root-knot nematode *M. incognita* that is the most dominant nematode under field and greenhouse conditions, cleared that varieties, Emma, Kawemira, Marathon and Sultan were the most resistant.

Emma was the least one in final population and the rates of penetration, reproduction, maturation and build-up. This variety could be used as commercial variety that will be cultivated in the infected soil by *M. incognita* nematodes.

Table (30): Rates of penetration, reproduction, maturation and build-up as a behavior of *Meloidogyne incognita* on roots of sugarbeet varieties in pots tests.

Investigated sugarbeet varieties	Behavior of M. incognita on tested varieties as			
	Penetration rate	Reproduction rate	Maturation rate	Build-up rate
Emma	4.6	1.7	1.9	6.1
Kawemira	7.8	3.7	5.1	10.1
Marathon	8.9	4.3	4.9	11.4
Sultan	15.0	5.4	6.3	16.6
L.S.D. 0.05	5.11	0.68	0.55	0.95
0.01	7.12	0.98	0.80	1.38

8. Relationship between initial population density (Pi) of *Meloidogyne incognita* and sugarbeet yields :

Relationships between numbers of the nematode, *M. incognita* in the soil at planting time and marketable yields of sugarbeet (cv. Chems) were studied in 200 plots on sand soil in the Ten thousand faddans area, West Nubaryia region.

Plots studied could be grouped according to the naturally occurring initial population density of the nematode, *M. incognita* into 13 levels. Their numbers ranked 15 to 387 larvae per 250 gm soil at planting. The influence of these levels of

initial population on gall formation and yields (roots and sugar/ fad.) of sugarbeet was reported in Table (31) and Figures (9 a, b, c, and d).

The results in Table (31) revealed that a general trend, however, was the gradual increase in the number of galls with increasing naturally initial population level (Pi). At harvest time, the number of galls per root was more greater (206) in case of high pi (387 larvae /250 gm soil) than (20 galls) with low one (15 larvae /250 gm soil). The increase in galls number was positively correlated ($P \geq 0.01$) with increasing of initial population level (Pi) as shown in Table (31).

Data in Table (31) and Figure (9a) also, show that sugarbeet yields per faddan were varied with the different levels of nematode densities at planting. All initial population levels for *M. incognita* seem to cause sugarbeet yields losses, which appeared in significant reduction of roots and sugar yields when compared with the low level as the check.

The roots yield decreased gradually with increasing the level of initial population density. Roots yield decreases in proportion to the initial population of the *M. incognita in* soil. The maximum yield of roots (43.9 tons/ fad.) was obtained with the lowest level of Pi, while, the minimum one was obtained with the highest Pi level. The percentage of proportional decrease from control in roots yield was more than 50 % only for level of 387 larvae /250 gm soil for *M. incognita*. This response refers to that the Pi level resulted in stunted plants with small root weight, which can't support high population of nematode.

Also, a progressive decline in sugar yield was observed with the increasing of the level of population at planting time, the lowest sugar yield was obtained by the highest level of Pi. Loss of sugar yield increased gradually to attain 51.3, 59.2 and 68.4 % by initial population densities of 325, 356 and 387 larvae /250 gm soil levels, respectively.

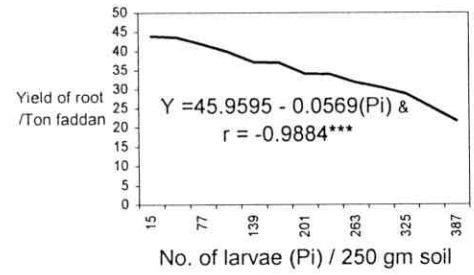
In the similar studies, the results indicated that the initial population of beet cyst nematode, *Heterodera shachtii* of 10 eggs + juveniles / gm soil resulted in root yield of sugarbeet losses between 1 and 64 % (Cooke and Thomason,1979; Greco *et al.*1982 and Cook, 1984).

From the previous data it can be concluded that *M. incognita* larvae attack sugarbeet plants resulting in decreasing in root and sugar yields. Yield loss % proportion to the initial population density of this nematode at planting time, generally, the rate of decrease or loss % in sugar yield was greater than in the root yield.

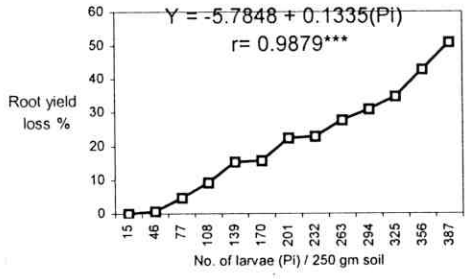
The reduction in root and sugar yield was negatively correlated ($P \geq 0.01$) with increasing of initial population density of *M. incognita* nematode at planting. The expected yield of sugarbeet (cv. Chems) at any level of initial population density of *M. incognita* at the planting could be achieved by using the constant (a) and regression coefficient (b) {regression equation} as shown in Table (32).

Table (31): Roots and sugar yields response of sugarbeet crop (var. Chems) to initial population densities of *Meloidogyne incognita* infesting soil of sugarbeet fields at Ten-thousand faddan area, West Nubaryia

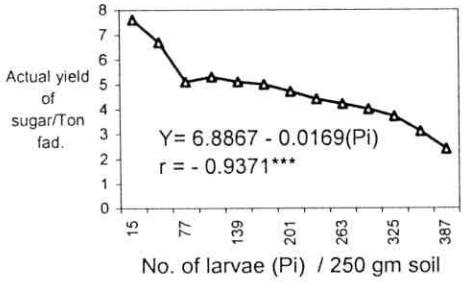
Level Rank	Pi as No. Larvae /250 gm soil	No. of Galls /root system	Actual Root yield Per ton/fad.	Root yield(y) as a proportion of max. y (%)	Root Yield loss (%)	Actual sugar yield/ ton fad.	Sugar yield(y) as a proportion of max. y (%)	Sugar Yield loss (%)
1	15	20	43.9	100.0	00.0	7.6	100.0	00.0
2	46	31	43.6	99.3	0.7	6.7	88.2	11.8
3	77	43	41.8	95.2	4.8	5.1	67.1	32.9
4	108	66	39.8	90.7	9.3	5.3	69.7	30.3
5	139	107	37.2	84.7	15.3	5.1	67.1	32.9
6	170	115	37.0	84.3	15.7	5.0	65.8	34.2
7	201	114	34.1	77.7	22.3	4.7	61.8	38.2
8	232	155	33.9	77.2	22.8	4.4	57.9	42.1
9	263	171	31.8	72.4	27.6	4.2	55.3	44.7
10	294	183	30.4	69.2	30.8	4.0	52.6	47.4
11	325	183	28.7	65.4	34.6	3.7	48.7	51.3
12	356	203	25.1	57.2	42.8	3.1	40.8	59.2
13	387	206	21.6	49.2	50.8	2.4	31.6	68.4



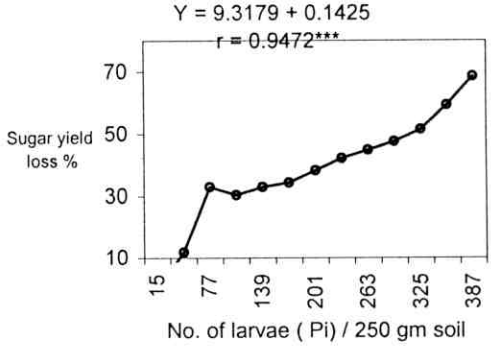
a)



(b)



(c)



(d)

Figure (9 a,b,c, and d): Roots and sugar yields response of sugarbeet crop (var. Chems) to initial population densities of *Meloidogyne incognita* infesting soil of sugarbeet fields at the Ten-thousand faddans area, West Nubaryia region.

Table (32): The relationship between initial population *Meloidogyne incognita* and sugarbeet yields.

Variabls	Mean (Range)	Correlation coefficient(r) between X & Ys	Regression equation between X & Ys (y = a + bx)
Initial population (Pi=x) Larvae/250 gm soil	201 (15-387)	_____	_____
Galls No./root system (Y_1)	122.8 (20-206)	+0.9820***	*** $Y_{1=16.3070 + 0.5408(Pi)}$
Root yield ton/ fad. (Y_2)	34.5 (21.6-43.9)	-0.9887***	*** $Y_{2=45.9595 - 0.0569(Pi)}$
Sugar yield ton/ fad. (Y_3)	4.7 (2.4-7.6)	-0.9371***	*** $Y_{3=6.8067 - 0.0169(Pi)}$

Tolerance limit " T " (the nematode density below which no detectable loss in yield occurs) could be calculated according to the equation :

$$Y = m = (1- m)* 0.95^{(P/T)-1}$$

$$with\ Z^{-T}\ equals\ The\ constant\ 0.95^{-T}$$

where, Y = the ratio between the average yield in the level with mean larvae density P, from the data in table (31) and by the above equation.

The " Tolerance limit " of Chems variety could be deduced as follows :-

for $P \geq T$ and $Y = 1$ for $P < T$

$$0.99 = 0.49 + (1 - 0.49)*0.95\ (46/T)^{-1}$$

$$0.99 = 0.49 + (0.51)*0.95\ (46/T)^{-1}$$

$$0.99 = 0.49 + 0.48 / (46/T)$$

$$0.99 - 0.49 = 0.48 * T/46$$

$$0.50 = (0.48 * T) /46$$

$$23.0 = (0.48 * T)$$

Hence T = 23.0 /0.48 = 48.0 larvae per 250 gm soil for var. Chems.

i.e. Tolerance limit for var. Chems at Pi = 48.0 larvae of *M. incognita* per gm.