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Effect of a Prolonged Practice of Crop Rotation and Fertilizer Treatment on the Nematode Fauna

By

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Abstract. The effect of organic and inorganic fertilizer treatment on the species and numbers of nematodes was studied at Bahteem Experimental Station, Egypt. Representative soil samples were collected from each treatment for counting, identifying and chemical analysis, and the following results were obtained.

1. A significant difference was recorded between rotations. The highest percentage of nematode species could be observed at one-year- and two-year rotations (40% and 38% respectively) and the lowest one was recorded at the three-years rotations (22%). **2.** Soils treated with farmyard manure were the ones containing the highest percentage of nematodes (38.10%). On the other hand, the lowest numbers of nematodes were recorded in soils fertilized with N, and NP (11.9% for each treatment), while the numbers observed in soils received NPK and control (19.05% for each treatment) were moderate. **3.** Forty nematode species were observed in the experimental side, twenty of them considered as new for the Egyptian fauna, eleven out of all nematode species illustrated as dominant species, which represent 68.32% of the total number of nematodes.

Introduction

It is well known that fertilization is the prime factor in maintaining soil fertility. As a rule, fertilizers are applied to the soil in the form of inorganic salts and organic manures. The former may be utilized directly and biologically transformed to other forms suitable for plant utilization. Organic manures, however, should be mineralized by soil micro-organisms to be available.

The dynamics of nematode populations in soils under numerous crops and rotations have been extensively studied (NUSBAUM & BARKER, 1971; GOOD & al., 1973), and nematode community structures have been analyzed (JOHNSON & al., 1972). Nematode populations under a particular crop have been correlated with soil and plant properties (NORTON & al., 1971; NYHAN & al., 1972). For example, GRANDISON and WALLACE (1974) analyzed the relationships of populations of *Pratylenchus thornei* SHER & ALLEN under strawberry clover (*Trifolium fragiferum* L.) to soil factors in eight different soils. However, there is little information at disposal on the long-term effects of different management practices under a constant vegetation.

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In the present work nematode populations have been determined in soils under different fertilization treatments. The relationship of these populations to the type of fertilizers and rotations have been determined.

The permanent fertilization experiment at Bahteem was found to be suitable for such investigations. In that experiment, soil received organic manure and different inorganic fertilizers under different conditions of rotation for nearly 56 years.

Nematode identification was accomplished after consulting the taxonomic works of Andrássy (1959, 1977), Goodey (1963), Heyns (1962), Meyl (1961), Tarjan (1973) and various other papers. The nematode species were ranked among the nomenclature and identified according to Andrássy's 1976 system.

Material and methods

Field selected

The permanent fertilization experiment at Bahteem was found to be suitable for the present investigation. The experiment had been established by the Egyptian Agricultural Society in 1919, for determining the effect of continuous application of fertilizers on the yields of crops. The fertilizer treatments and the total quantities of applied fertilizers per feddan from 1919 till 1975 were as follows:

O: received no fertilizers (control);
N: received sodium nitrate (10 000 kg);
NP: received sodium nitrate (10 000 kg), superphosphate (7200 kg);
NPK: received sodium nitrate (10 000 kg), superphosphate (7200 kg) and putassium sulphate (5700 kg);
FYM: received farmyard manure (1 290 000 kg).

Rotation

See the rotation system in Table 1.

Table 1. Rotation system at Bahteem Experimental Station

Years Rotations	1	2	3	4	5	6
1-year	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton
2-years	Cotton	Maize after wheat	Cotton	Maize after wheat	Cotton	Maize after wheat
3-years	Cotton	Maize after clover	Maize after wheat	Cotton	Maize after clover	Maize after wheat

Table 2. The chemical analysis of soils dressed with organic and inorganic fertilizers under different conditions of rotation

Treatment	Rotation	N	NP	NPK	FYM	Cont. (0)
Ca	1-year	0.26	0.30	0.45	1.05	0.45
	2-years	0.50	0.40	0.55	0.75	0.60
	3-years	0.65	0.50	0.55	0.90	0.87
Mg	1-year	0.66	0.60	0.42	0.77	0.65
	2-years	0.30	0.25	0.30	0.70	0.67
	3-years	0.60	0.55	0.40	0.63	0.40
K	1-year	0.05	0.04	0.06	0.40	0.08
	2-years	0.03	0.03	0.04	0.59	0.06
	3-years	0.03	0.03	0.03	0.18	0.03
Na	1-year	2.17	2.22	2.75	1.60	1.95
	2-years	2.30	2.25	2.75	1.70	1.50
	3-years	1.80	1.75	1.75	1.70	1.45
CO_3	1-year	0.30	0.30	0.20	0.30	0.25
	2-years	0.40	0.40	0.25	0.15	0.20
	3-years	0.25	0.20	0.15	0.10	0.15
HCO_3	1-year	1.75	1.50	1.55	1.85	1.55
	2-years	1.90	1.60	1.70	2.00	1.35
	3-years	1.45	1.00	1.70	1.80	1.55
Cl	1-year	0.85	0.80	1.47	1.45	1.00
	2-years	0.80	0.72	1.30	1.58	1.00
	3-years	0.87	1.00	0.67	1.40	0.80
SO_4	1-year	0.23	0.60	0.47	0.17	0.25
	2-years	0.16	0.16	0.50	1.08	0.35
	3-years	0.68	0.66	0.21	0.13	0.20

(0) Received no fertilizers;
N Received sodium nitrate;
NP Received sodium nitrate and superphosphate;
NPK Received sodium nitrate, superphosphate & potassium sulphate;
FYM Received farmyard manure.

Field sampling

In the present investigation representative samples were collected. A sampling tube (2 inches in diameter and 12 inches long) was used. Soil samples of each plot (of all the 15 plots) were thoroughly mixed and then heeped into a conical pile. This pile was vertically divided by a blade into two equal parts. Each half was subsequently divided into four equal parts each of which representated one eighth of the original pile. A one eighth portion was made into another conical pile, and subdivided into two equal parts. The latter fractional part, which represented one sixteenth of the original pile, was divided into two parts (each of them 100 g), the first one of these for nematode investigations, the second for chemical analyses (Table 2).

Chemical analyses

Representative soil samples from each plot were taken for chemical analysis to be done at the Department of Chemistry, Faculty of Science, Al-Azhar University, Cairo.

Nematode extraction

A modification of the methode of COBB (1918), as well as of CHRISTIE and PERRY (1951) for extracting nematodes from soils was used by ANDRÁSSY as follows:

About 300 – 400 ml of water was added to the representative soil sample in a plastic pan and the mixture was agitated with the fingers. After a few seconds the suspension was poured onto a 50 mesh sieve, while the passing suspension was received on a 400 mesh sieve where it was thoroughly washed in a gentle stream of water. The organic matter including nematodes settled on the sieve was quantitatively transferred into a 500 ml beaker. Similarly after a few seconds, 2/3 of the suspension was poured again on the sieve and washed in a gentle stream of water; the remainder of the suspension was ten transferred to a Petri dish and thereafter to a test tube.

Fixation

Nematodes were killed and fixed in FAA (40% formalin 6 parts, glacial acetic acid 1 part, 70% alcohol 20 parts, and distilled water 40 ml).

Clearing and mounting

For clearing, nematodes are transferred from fixative to a small watch-glass containing about 0.5 ml of the following mixture: 70% alcohol 8 parts, glycerin 1 parts, distilled water 1 part. The watch-glass with the nematodes is left resting for at least 48 hours before mounting.

For mounting, glycerin gives the best results as a medium. In any medium it is important to mount small piece of allomenium paper of about the same diameter as the nematodes or somewhat thicker along with the specimens, and these supports are arranged radially towards the edge of the drop. Finally, the drop is covered with a thin cover-slip, the edges of which are sealed with white synthetic lac.

Results and discussion

The effect of the prolonged use of fertilizers and rotation on the species and percentage of nematodes is shown in Table 3.

Table 3. Effect of rotation and fertilizer treatments on the species and numbers of nematodes

Treatment	X'%	X'%	Rotation	X'%
N	0.10	0.12	1-year	0.20
NP	0.10			
NPK	0.16		2-years	0.19
FYM	0.32	0.32	3-years	0.11
(0)	0.16	0.16		

Series	Nematode species	X'%	Series	Nematode species	X'%
1	*Cephalobus persegnis*	0,96	21	*Acrobeloides emarginatus*	0.10
2	*Tylenchorhynchus goffarti*	0.54	22	*Longidorus* sp.	0.08
3	*Thornenema viriosum*	0.52	23	*Discolaimoides filiformis*	0.08
4	*Cervidellus soosi*	0.40	24	*Mylonchulus sigmaturus*	0.08
5	*Dorylaimellus projectus*	0.37	25	*Plectus paracommunis*	0.07
6	*Helicotylenchus digonicus*	0.35	26	*Eudorylaimus projectus*	0.06
7	*Discolaimoides bulbiferus*	0.33	27	*Oionchus obtusus*	0.06
8	*Pratylenchus vulnus*	0.28	28	*Tripyla* sp.	0.05
9	*Filenchus filiformis*	0.28	29	*Rotylenchus reniformis*	0.04
10	*Eudorylaimus nothus*	0.27	30	*Belondira cylindrica*	0.03
11	*Hoplolaimus aegypti*	0.25	31	*Deladenus saccatus*	0.03
12	*Acrobeles complexus*	0.18	32	*Hemicriconemoides affinis*	0.03
13	*Thornenema laevicapitatum*	0.17	33	*Merlinius brevidens*	0.03
14	*Panagrolaimus* sp.	0.16	34	*Heterocephalobus buchneri*	0.03
15	*Eucephalobus oxyuroides*	0.13	35	*Tylenchorhynchus cylindricus*	0.02
16	*Nygolaimus* sp.	0.13	36	*Aphelenchus avenae*	0.02
17	*Tobrilia imberbis*	0.12	37	*Paramphidelus uniformis*	0.02
18	*Dorylaimus* sp. *(stagnalis)*	0.12	38	*Ecumenicus monohystera*	0.02
19	*Ditylenchus intermedius*	0.11	39	*Alaimus* sp.	0.02
20	*Psilenchus hilarulus*	0.10	40	*Aporcelaimellus* sp.	0.02

L.S.D. for treatments	0.09
L.S.D. for rotations	0.07
L.S.D. for species	0.25
L.S.D. for inorganic organic	0.07
L.S.D. for inorganic control (0)	0.07
L.S.D. for organic control (0)	0.09

The effect of the rotation system

The rotation system brought significant results in the present investigation. In case of one-year- and two-years rotation a higher number of nematodes (40% and 38%, respectively) were found. On the other hand, in case of a three-years rotation the number of nematodes was lower (22%). This may be attributed to a one or two years absence of host plants to nematodes in the two- and three-years rotations.

Brodie & al. (1970) suggest a selection and variation of crop plants with diverse abilities of supporting different species of plant parasitic nematodes so that the rise to damaging levels in newly cleared agricultural lands of tropical and subtropical regions may be delayed.

The effect of fertilizer treatments

Fertilization used in this investigation included inorganic fertilizers and organic manure, in addition to the control.

The percentage of nematodes significantly increased in the treatment with FYM, higher than in the other treatments. On the other hand, the lowest per-

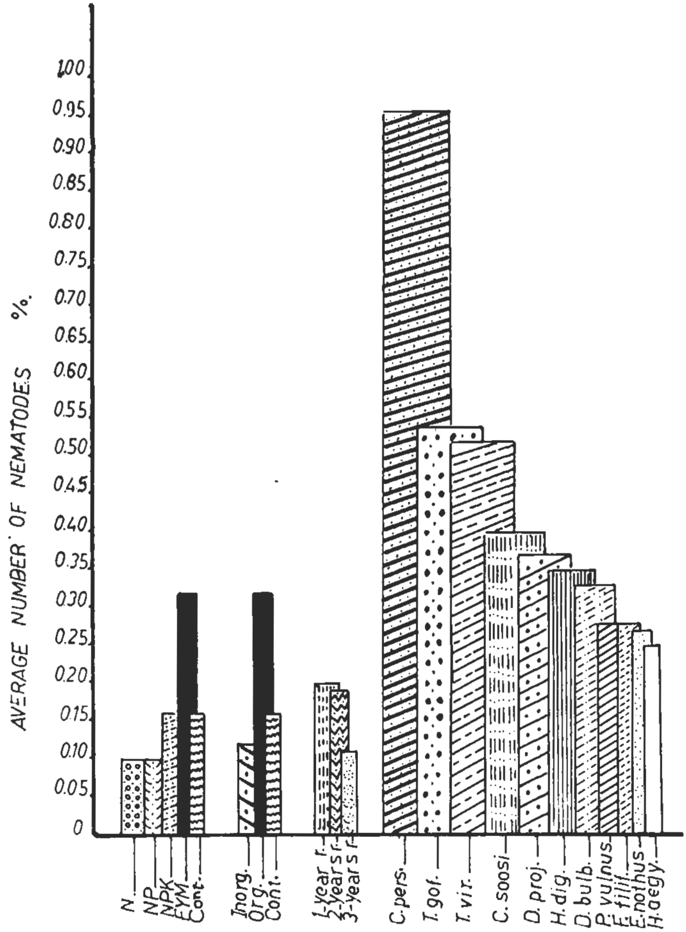

Fig. 1. Effect of rotation and fertilizer treatments on the percentage number of nematode species

centage was recorded in treatments with N and NP, while a moderate number of nematodes was observed in treatment with NPK and in the control.

In general, the application of FYM significantly increased the total number of nematode species. This may be attributed to the increase of the potassium and decrease of the sodium content (Table 2). The application of inorganic fertilizers, namely sodium nitrate, superphosphate and potassium sulphate, relatively decreased the percentage of nematodes. However, it should be stated that the treatment with NPK slightly increased the percentage of nematodes, and this may be attributed to a direct supply of nitrogen, phosphorus and potassium considered to be essential in the nutrition of soil organisms, and indirectly to increasing crop yields and, consequently, plant residues and soil nematodes, too.

The effect of fertilization and rotation on the nematode species

In this study highly significant differences have been found among the species. Forty species were recorded during the investigation, twenty of them can be considered as new for the Egyptian fauna (Table 4). Eleven species (Table 3. represent the most dominant, dominant and subdominant species (30.33%, 21.77% and 16.22% of the total nematode number, respectively). Other species (from 12 to 40 in Table 3) were observed in few number.

Table 4. New records of nematodes from Egypt

Family	Series	Nematode species	Author
Plectidae	1	*Plectus paracommunis*	HOEPPLI, 1926
Cephalobidae	2	*Acrobeles complexus*	THORNE, 1925
	3	*Acrobeloides emarginatus*	(DE MAN, 1980) THORNE, 1937
	4	*Cervidellus soosi*	(ANDRÁSSY, 1953) GOODEY, 1963
	5	*Eucephalobus oxyuroides*	(DE MAN, 1876) STEINER, 1936
Tylenchidae	6	*Filenchus filiformis*	(BÜTSCHLI, 1813) MEYL, 1961
Anguinidae	7	*Ditylenchus intermedius*	(DE MAN, 1880) FILIPJEV, 1936
Neotylenchidae	8	*Deladenus saccatus*	ANDRÁSSY, 1954
Criconematidae	9	*Hemicriconemoides affinis*	LUC, 1970
Alaimidae	10	*Paramphidelus uniformis*	(THORNE, 1939) ANDRÁSSY, 1977
Tripylidae	11	*Tobrilia imberbis*	(ANDRÁSSY, 1953) ANDRÁSSY, 1957
Mononchulidae	12	*Oionchus obtusus*	COBB, 1913
Thornenematidae	13	*Thornenema laevicapitatum*	(THORNE & SWANGER, 1936) ANDRÁSSY, 1959
	14	*Thornenema viriosum*	WILLIAMS, 1964
Qudsianematidae	15	*Discolaimoides filiformis*	DAS, KHAN & LOOF, 1969
	16	*Ecumenicus monohystera*	(DE MAN, 1880) THORNE, 1974
	17	*Eudorylaimus nothus*	THORNE & SWANGER, 1936) ANDRÁSSY, 1959
	18	*Eudorylaimus projectus*	THORNE, 1939
Belondiridae	19	*Belondira cylindrica*	THORNE, 1964
Dorylaimellidae	20	*Dorylaimellus projectus*	HEYNS, 1962

The most dominant species were *Cephalobus persegnis*, *Tylenchorhynchus goffarti* and *Thornenema viriosum*. The species *Cervidellus soosi*, *Dorylaimellus projectus*, *Helicotylenchus digonicus* and *Discolaimoides bulbiferus* represented the dominant species in the investigation samples. The subdominant nematodes were *Pratylenchus vulnus*, *Filenchus filiformis*, *Eudorylaimus nothus* and *Hoplolaimus aegypti*.

All the above eleven species make out 68.32% of the total number of nematodes. Other species from 12–40 represent 31.68% of the total number of nematodes.

Some of the dominant species, e. g. *Cephalobus persegnis* and *Cervidellus soosi* prefer dry or sandy soils, but here they were dominant species, which may be attributed to the effect of prolonged fertilization.

Table 4 shows 20 records of nematodes new for the Egyptian fauna, belonging to 13 families and 18 genera of free-living and plant-parasitic nematodes.

In 1978 I listed 120 species and two subspecies of nematodes recorded from Egypt till that year. Now the total number of the Egyptian soil nematodes will be 140 species and two subspecies.

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