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ROOT KNOT (*MELOIDOGYNE INCOGNITA*) ON LOOFA (*LUFFA AEGYPTIACA* L.): OCCURRENCE, CONTROL AND FRUITS YIELD

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Abstract

Field surveys were conducted in loofa fields of seven governorates in 1997 and 1998. Infection percentages were always increased by approximately 3-6 folds by repeatedly using the same soil, although some sanitary measures were adopted. Infection ranges were (13.1-15.3%), (40.8-47.5%) and (79.1-89.1%) in the plants grown for one, two and three successive seasons in the same field soil, respectively.

Three nematicides and one biocide (Nemaless) singly and in combinations were evaluated against the disease. All treatments effectively reduced number of galls by 20.5-100.0%, egg-masses by 44-100% and second-stage larvae by 25-100% in the root and soil. The highest reduction was obtained with the application of Temik and Nemacur at the rate of 10 gm/plant, while the least was associated with Nemaless or Vydate. In most cases, spraying Vydate on plants grown in Nemacur or Temik-treated soil decreased their positive effectiveness against this nematode.

Sufficient increases in fruit yield quantity per plant (20.00-81.25%) and improving in quality by decreasing number of short and medium fruits as well as increasing long ones by 11.11 to 191.65% were recorded. Temik and Nemacur (10 gm per plant) were the most effective treatments, while, Vydate and Nemaless were the least. Applying Vydate on loofa plants grown in Temik or Nemacur-treated soil always decreased their efficacy in increasing fruits yield.

INTRODUCTION

Loofa (Loofah, sponge gourd) cultivated in Egypt is *Luffa aegyptiaca* L. (*L. cylindrica* M. Roem). It is an important summer crop with high profitable income per feddan, usually cultivated in the same land for more than three successive seasons since woody or iron bars needed for growing the plants are expensive.

Considerable losses in plant stand and vigor as well as fruits yield has been observed by increasing number of successive planting seasons in the same land. This is due the annual increase in populations of soilborne pathogens especially root-knot nematodes. Soilborne fungal diseases were recently investigated by Hilal *et al.* (2001), while nematode diseases were not.

Root-knot nematodes caused by *Meloidogyne incognita*, *M. javanica* and *M. hapla*

were reported on loofa (*L. aegyptiaca* and *L. acutangula*) by several investigators (Narbaev and Allamuratov, 1984; Ahuja and Muchopadhyaya, 1985; Soni and Joshi, 1985 and Paruthi *et al.*, 1995). *M. incognita* was, however, the highly pathogenic nematode, and capable of causing galls during the early stage of infection. Prevalence of these nematodes were affected by humidity and alkalinity of soil as well as the grown crops (Soni and Joshi, 1985). On the other hand, nematode infection caused abnormal xylem formation in the roots, progressed incessantly as the gall grew older (Hisamuddin and Siddiqui, 1992). Infected roots had abnormal development of xylem, occurring in irregular patches with scattered vessel elements (Hussain and Raza, 1993).

Disease management was achieved on loofa plants with nematicide fenamiphos (chemical control) and nematophagous fungus *Paecilomyces lilacinus* (biological control) as reported by Giraldo *et al.* (1996).

The objective of the present investigation was to study the magnitude of the nematode problem of loofa in Egypt and to define some means for its control.

MATERIALS AND METHODS

I. Disease survey:

A survey was performed in two successive seasons 1997 and 1998, in some loofa plantations of seven governorates, i.e. Behera, Dakhlyia, Qalubyia, Sharkyia, Assuit, Beni-Suief and Giza, in order to determine root-knot nematode infection. The examined fields in each governorate included those of plants (5-6 months-old) grown for one, two and three successive seasons in the same soil. Moreover, 50-75 plants/feddan, distributed in four marked areas where plants are characterized by weak foliar growth and/or dry leaves, were chosen and examined for each field. The surface layers of soil (10-20 cm) around the plant was gently removed in order to examine root system with the aid of an eye lens if necessary. Also 5 samples from infected tissues were collected for microscopic examination, after they were hand sectioned, to verify infection.

Severity of infection was negligible, therefore, a plant was counted amongst the infected ones by detecting any number of true galls. Finally, mean of infection percentages for each governorate was calculated. On the other hand, cropping history, if available, for each field during the previous two years as well as any information related to control means such as nematicide(s), biocide(s) or solarization, which may have been be applied before or during the growing season, were collected.

II. Disease control:

1. Effect of three nematicides and one biocide on the nematode populations in roots and soil:

Naturally, heavy infested field soil (approx. 460 nemas per 250 gm soil of root-knot nematodes, *Meliodogyne incognita*) near Mashtul, Sharkyia governorate, previously planted with loofa for several years was chosen. Treatments were arranged in a complete randomized block design with four replicates. The field plot was 60 m^2 (5 x 12 m) with three rows. The growing seedlings (45 days) were thinned and only one plant was left to grew in each hill. Irrigation and fertilization were adopted as usual.

Three nematicides, i.e. Nemacur, Temik and Vydate and one biocide namely Nemaless (a bacterial bioagent containing *Serratia marcescens*) were used in these experiments in 12 treatments. Temik and Nemacur were added at the time of planting at the rate of 10 gm and 20 gm/plant, whereas Vydate and Nemaless were applied once and twice after 4 and 6 weeks from germination with the rate of 3 and 10 liters per feddan, respectively. The combination treatments were, however, carried out by using Vydate (3 liters/feddan), once after four weeks from germination, to the treatments of Temik and Nemacur (10 gm and 20 gm/plant). Four plots without any treatments served as control.

In order to determine the efficacy of these treatments in disease control, 250 gm of soil in addition to root samples per each treatment and the control were collected two months after application for examination. Numbers of galls and egg masses in one gram of roots and number of L2 larvae in the soil samples were determined for each treatment.

2. Effect of three nematicides and one biocide through fruit yield of loofa plants:

Fruit yield per plant as total numbers produced throughout the season were recorded. These fruits were, however, divided into three catogeries for fruit lengths, namely, short (25-40 cm), medium (40-60 cm) and long (60-75 cm) to define yield quality. Efficacy of each treatment in nematode control and in increasing the yield both quantitatively and qualitatively was calculated.

RESULTS AND DISCUSSION

I. Disease survey:

Data in Table (1) indicate that root-knot nematode (Fig., 1) was detected in fields of all surveyed governorates. Mean percentages of infection were found to range between (13.1-15.3%), (40.8%-47.5%) and (79.1-89.1%), in the plants grown for one, two and three successive seasons in the same field soil, respectively.

Infection percentages always increased by increasing number of grown seasons in the same soil, even some sanitary means were adopted. These increases reached approximately three folds in the fields sown with loofa for two successive seasons compared with those planted for only one season. Moreover, disease incidence increased by approximately two folds in the third season of planting of that recorded in the second season. In other words, infected plants progressively increased over the three successive seasons reaching six-times in the third season as much as those recorded in the first. As for governorates, fields of Behera, Qalubyia and Sharkyia exhibited generally, the highest percentages of infection; although > 1 to 6% of the areas cultivated in Behera and Qalubyia were irregularly treated with nematicide(s), approximately 10% of these areas were cultivated with one or more crops (tomato, sunflower or loofa) in the last two years before planting with loofa. Increases occurred in infection percentages during the second season of planting in non-nematicide-treated fields of Dakhlyuia, Sharkyia and Beni-Suief than those of first season reached more than (5-7) and (5-10) folds during first and second seasons of survey, respectively. Also, percentages of infection reached more than 90% in the third season of planting in Behera (90.2%) and Sharkyia (94.5%) during 1997 as well as Behera (93.8%), Qalubyia (98.3%), Sharkyia (90.9%) and Beni-Suief (94.4%) during 1998.

According to the available literature, there have been no previous studies concerning root knot nematode disease on loofa in Egypt, whereas the disease was reported on different loofa species (Soni and Joshi, 1985; Hussain and Raza, 1993 and Paruthi *et al.*, 1995). The high disease incidence was attributed to planting loofa for more than three successive seasons in the same soil, thus neglecting crop rotation, alkalinity and high humidity of soil and that very weak sanitation and controlling programmes were adopted by the growers. In this respect, (Soni and Joshi, 1985) mentioned that prevalence of root knot diseases were higher in areas with higher humidity than in dry areas. They also found that soil alkalinity favoured *Meloidogyne* spp. infection in loofa.

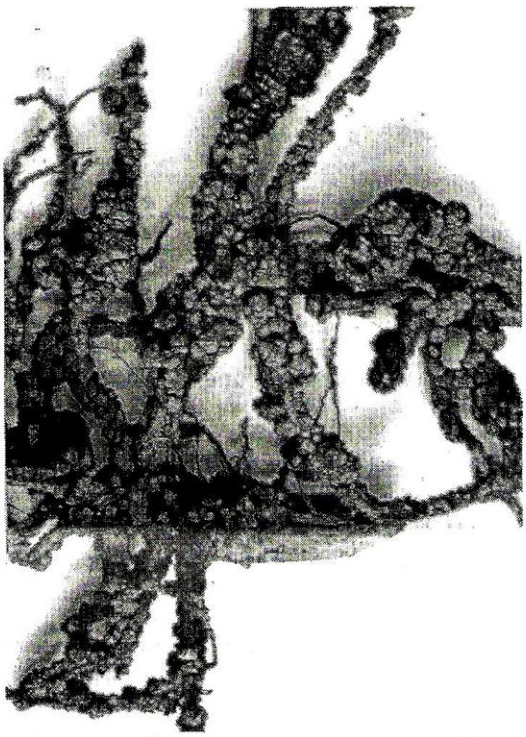

Fig. 1. Root-knot symptoms on loofa roots caused by Meloidogyne incognita, showing great abnormal development.

Table 1. Mean percentage of disease incidence on loofa plants (5-6 months-old) sown for one, two or three successive season(s) in the same fields of seven governorates, 1997 & 1998 season.

Governorates	% of infection after season(s) of planting in the same field, 1997				% of infection after season(s) of planting in the same field, 1998			
	1st	2nd	3rd	Mean	1st	2nd	3rd	Mean
Behera	20.6	58.1	90.2	56.3	23.0	49.5	93.8	55.4
Dakhlyia	5.9	40.5	72.8	39.7	5.7	41.6	88.8	45.3
Qalubyia	22.6	47.6	63.6	44.6	36.8	70.0	98.3	68.4
Sharkyia	8.7	53.4	94.5	52.2	9.9	50.2	90.9	50.3
Assuit	10.8	26.9	87.2	41.6	5.3	30.0	80.7	38.7
Beni-Suief	7.2	39.5	89.0	45.2	4.8	46.1	94.4	48.4
Giza	16.1	20.3	56.9	31.1	21.8	44.7	77.0	47.8
Mean13.1	40.8	79.1	-	15.3	47.5	89.1	-	

Disease control:

1. Effect of three nematicides and one biocide on the nematode in roots and soil:

Data in Table (2) reveal that all the treatments under investigation reduced the number of galls, number of egg-masses and the number of second stage larvae in the soil. These findings are in harmony with the findings of many investigators (Stephan *et al.*, 1991 and Averre *et al.*, 1995) who used different nematicides to control the root-knot nematode on cucumber or cantaloupe.

The highest reduction was obtained with the application of Nemacur and Temik at the rates applied, although Temik was more effective than Nemacur.

The combinations of Vydate with any of the two nematicides (Temik or Nemacur) reduced their efficacy to control the nematode in the plant tissues. The rate of reduction in the number of galls and number of egg-masses attributed to the application of Temik or Nemacur was reduced when the Vydate was applied in combination with them. This adverse effect was more obvious between Vydate and Nemacur than between Vydate and Temik.

The least reduction in nematode was obtained with the bio-agent Nemaless

which reduced the number of galls by about 30% and the number of egg-masses by 50-70%. These results can be explained in the light that Nemaless involves the bacteria *Serratia marcescens* which produce the enzyme chitinase and can cause premature hatching of nematode eggs and could be used as an aid in the control of nematode (Mercer *et al.*, 1992).

Table 2. Reduction in the reproduction of *M. incognita* caused by nematicides and Nemaless applications in roots and soil.

Treatments	In roots (one gm)				No. of juveniles in 250 gm soil	Reduction (%)
	No. of galls(1)	Red.%(2)	No. of EM(3)	Red. %		
Vydate (one time)	17.5	20.5	7.5	44.0	667	33.3
Vydate (two times)	10.0	54.5	2.0	85.1	0	100.0
Nemaless (one time)	15.3	30.5	6.7	50.0	750	25.0
Nemaless (two times)	14.5	34.1	3.2	76.1	667	33.3
Nemocur (10 gm.)	1.3	94.1	0.0	100.0	145	85.7
Nemocur (10 gm. + Vydate)	4.7	78.6	2.7	79.9	77	92.3
Nemocur (20 gm.)	2.0	90.0	0.0	100.0	0	100.0
Nemocur (20 gm. + Vydate)	7.3	66.8	4.0	70.1	0	100.0
Temik (10 gm.)	0.0	100.0	0.0	100.0	0	100.0
Temik (10 gm. + Vydate)	5.0	77.3	2.5	81.3	0	100.0
Temik (20 gm.)	0.0	100.0	0.0	100.0	0	100.0
Temik (20 gm. + Vydate)	0.0	100.0	0.0	100.0	0	100.0
Control	22.0	0.0	13.4	0.0		0.0

(1) Number of galls in one gram roots.

(2) % Reduction relative to control.

(3) EM = Number of egg-masses in one gram roots.

The effect of Nemaless can also be attributed to its growth stimulation which helps to reducing the damage of nematode by encouraging growth of the root-system. This stimulation effect was observed by Alkahal *et al.* (1999), who reported that soybean treated with "Nemaless" showed an increase in plant growth and yield. On the other hand, using the nematicides Nemacur and Vydate against *Meloidogyne* spp., infecting cucurbitaceous plants, resulted in a significant reduction in nematode population (Stephan *et al.*, 1991 and Averre *et al.*, 1995).

2. Effect of three nematicides and one biocide on fruit yield per plant:

Data presented in Tables (3 and 4) indicate that all the tested treatments increased number of fruits per plant over the control in both seasons, 1998 and 1999. Increases ranging between (20-60%) and (31.25-81.25%) were recorded in both experimental seasons. Temik and Nemacur at the rate of 10 or 20 gm/plant were the best treatments in increasing yield quantity, i.e. number of fruit yield/plant, and there was no superiority of 20 gm rate over 10 gm in this respect. Vydate or Nemaless (once or twice) were the least effective treatments compared with the others. Also, applying Vydate as spraying treatment one month after applying Temik or Nemacur to soil resulted in reduction of positive efficiency induced by each one alone of these nematicides.

Table 3. Effect of nematicides and nemaless application on fruits yields per loofa plant, 1998 season.

Treatments	No. of fruits per plant	% change*	No. of fruits in each category			% of fruits in each category			% of change*		
			A	B	C	A	B	C	A	B	C
Vydate (one time)	18	20.00	3	11	4	16.67	61.11	22.22	49.99(-)	30.94	11.10
Vydate (two times)	20	33.33	2	12	6	10.00	60.00	30.00	70.00(-)	28.56	50.00
Nemaless (one time)	18	20.00	3	10	5	16.67	55.56	27.77	49.99(-)	19.05	38.85
Nemaless (two times)	19	26.67	3	9	7	15.79	47.37	36.84	52.63(-)	1.50	84.20
Nemocur (10 gm.)	23	53.33	2	9	12	8.70	39.13	52.17	73.90(-)	16.16(-)	160.85
Nemocur (10 gm. + Vydate)	21	40.00	2	13	6	9.52	61.91	28.57	71.44(-)	32.66	42.85
Nemocur (20 gm.)	22	46.67	2	10	10	9.09	45.46	45.45	72.73(-)	2.59(-)	127.25
Nemocur (20 gm. + Vydate)	20	33.33	3	8	9	15.00	40.00	45.00	55.00(-)	14.29(-)	125.00
Temik (10 gm.)	24	60.00	1	10	13	4.17	41.67	54.16	87.49(-)	10.71(-)	170.80
Temik (10 gm. + Vydate)	21	40.00	2	10	9	9.52	47.62	42.86	71.44(-)	2.04	114.30
Temik (20 gm.)	24	60.00	1	9	14	4.17	37.50	58.33	87.49(-)	19.65(-)	191.65
Temik (20 gm. + Vydate)	23	53.33	2	9	12	8.70	39.13	52.17	73.90(-)	16.16(-)	160.85
Control (without treatments)	15	-	5	7	3	33.33	46.67	20.00	-	-	

* Decreases (-) or increases relative to control.

A Fruits of 25-40 cm long (short fruits).

B Fruits of 40-60 cm long (medium fruits).

c Fruits of 60-75 cm long (long fruits).

All the tested treatments improved fruit quality by decreasing number of short (25-40 cm) and medium (40-60 cm) fruits in most cases and increasing number of long ones (60-75 cm) in all cases. Increases ranged between (11.1-191.65%) and

(26.97-185.71%) for long fruits were recorded in the two seasons, respectively. Temik and Nemacur treatments gave, however, the maximum increases and the minimum increases were found with Vydate and Nemaless.

Table 4. Effect of nematicides and nemaless application on fruits yields per loofa plant, 1999 season.

Treatments	No. of fruits per plant	% * of increases	No. of fruits in each category			% of fruits in each category			% of decreases* or increase		
			A	B	C	A	B	C	A	B	C
Vydate (one time)	21	31.25	4	12	5	19.05	57.14	23.81	39.04(-)	14.28	26.97
Vydate (two times)	22	37.50	4	11	7	18.18	50.01	31.82	41.82(-)	00.02	69.71
Nemaless (one time)	21	31.25	5	11	6	23.81	52.38	23.81	23.81	4.76	26.97
Nemaless (two times)	23	43.75	6	11	6	26.09	47.83	26.08	16.51	4.34(-)	39.09
Nemocur (10 gm.)	27	68.75	3	11	13	11.11	40.74	48.15	54.45(-)	18.52(-)	156.80
Nemocur (10 gm. + Vydate)	24	50.00	4	14	6	16.67	58.33	25.00	46.66(-)	16.66	33.33
Nemocur (20 gm.)	26	62.50	3	12	11	11.54	46.15	42.31	63.07(-)	7.70(-)	125.65
Nemocur (20 gm. + Vydate)	23	43.75	5	10	8	21.74	43.48	34.78	30.43	13.04(-)	85.49
Temik (10 gm.)	28	75.00	2	11	15	7.14	39.29	53.57	77.15(-)	21.42(-)	185.71
Temik (10 gm. + Vydate)	26	62.50	4	11	11	15.39	42.31	42.30	50.75(-)	15.38(-)	29.60
Temik (20 gm.)	29	81.25	2	12	15	6.90	41.38	51.72	77.92(-)	17.24(-)	175.84
Temik (20 gm. + Vydate)	28	75.00	3	12	13	10.71	42.86	46.43	65.73(-)	14.28(-)	147.63
Control (without treatments)	16	-	5	8	3	31.25	50.00	18.75	-	-	-

* Decreases (-) or increases relative to control.

A Fruits of 25-40 cm long (short fruits).

B Fruits of 40-60 cm long (medium fruits).

C Fruits of 60-75 cm long (long fruits).

In this respect, Lawrence and Mclean (1995) and Kwon-Taeyoung *et al.* (1998) reported similar increases in fruit yields of melon by using nematicides against *Meloidogyne* spp. However, the increases in fruit yield reached 14%-21%.

Based on the foregoing results, it is concluded that nematode infection could assume damaging proportions in loofa in the absence of proper rotation. Moreover, the application of control measures, particularly Temik and Nemacur provide an effective control leading to increased yield both quantitatively and qualitatively.

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مرض تعقد الجذور النيماتودى المتسبب عن "ميلودوجين انكوجنيتا" على اللوف: تواجده، وسائل مكافحته ومحصول الثمار الناتج

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أجرى حصر للمرض خلال عامى ٩٧، ١٩٩٨م فى الحقول المنزرعة باللوف بسبعة محافظات مختلفة. ولقد وجد أن الإصابة بالمرض تزداد سنوياً حتى تصل إلى ٣-٦ أضعاف تقريباً بزيادة عدد مرات الزراعة المتتالية فى نفس التربة حتى وإن طبقت بعض الوسائل الوقائية. ولقد تراوحت نسب الإصابة ما بين (١,١٣-١٥,٣٪)، (٨,٤٠-٤٧,٥٪)، (١,٧٩-٨٩,١٪) وذلك فى الأراضى التى تمت زراعتها لموسم واحد، موسمين وثلاثة مواسم متتابعة، على التوالى.

تم تقييم فعالية ثلاثة مبيدات نيماتودية، مبيد حيوى (نيماليس) فى مقاومة المرض عند استخدامها منفردة أو مجتمعة. ولقد خفضت هذه المعاملات منفردة وبفعالية محسوسة عدد العقد النيماتودية (٥,٢٠-١٠٠٪)، كتل البيض (٥,٤٤-١٠٠٪)، الجيل الثانى من اليرقات (٢٥-١٠٠٪) فى الجذور والتربة. كما تم الحصول على أعلى فعالية مع استخدام التيميك ، النيماكور بمعدل ١٠ جم/نبات بينما كانت أقل فعالية عند إستخدام النيماليس أو الفايديت. ووجد أيضاً أن رش الفايديت على النباتات النامية فى تربة معاملة بأى من التيمك أو النيماكور يؤدى فى معظم الحالات إلى خفض فعالية الأخيرين فى مقاومة النيماتودا.

أدى استخدام أى من المعاملات المختبرة إلى زيادة معنوية فى محصول الثمار للنبات الواحد كما (٢٠,٠٠ - ٨١,٢٥٪) ونوعاً بخفض أعداد الثمار القصيرة والمتوسطة وزيادة أعداد الثمار الطويلة بنسبة تتراوح ما بين ١١,١١٪ إلى ١٩١,٦٥٪. ولقد كان مبيدى التيمك والنيماكور أكثر المبيدات فعالية بينما كان مبيدى الفايديت والنيماليس أقلها تأثيراً. كما أدى استخدام الفايديت رشاً على نباتات اللوف النامية فى تربة معاملة بالتيمك أو النيماكور إلى خفض تأثيرها الموجب فى زيادة محصول الثمار للنبات الواحد.