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Effect of Integrating Inorganic Fertilizer with either Micronema, Compost, or Oxamyl on Suppressing Plant Parasitic Nematode *Meloidogyne incognita* Infecting Tomato Plants under Field Conditions.

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ABSTRACT

Integrated regimens conducted during two successive seasons in Kafr- Hakim rejoin Giza governorate. The aim was to assess the protective value of different combinations; either the commercial bioproduct Micronema containing the two rizobacteria *Bacillus spp*., and *Pseudomonas fluorescence*, compost as organic amendment or chemical nematicide Oxamyl (vaydate 24%) along with NPK as inorganic soil fertilizer in controlling root knot nematode *Meloidogyne incognita* and their effects on the tomato yield production. The recorded data showed that all tested products significantly reduced the final nematode population and improved yield production. The effects varied among treatments in the following descending pattern. First, Oxamyl along with NPK treatment overwhelmed other treatments in decreasing nematode final population and improving yield production. Secondly, the application of the inorganic fertilizer NPK alone. Thirdly, compost along with NPK treatment. The bionematicide Micronema along with NPK treatment showed the lowest percentage reduction in the nematode development parameters and the lowest percentage increase in tomato growth. In spite of our findings that Oxamyl along with NPK overwhelmed all the treatments in controlling nematode and increasing tomato growth, the authors recommend integrated application of inorganic and organic fertilizers such as NPK and compost to maintain root knot nematode infecting tomato plant at low threshold level, and to keep more safe environment.

Key words: *Meloidogyne incognita*, Tomato plants, Organic and inorganic fertilizers, Micronema, Oxamyl.

Introduction

In Egypt, Root knot nematode, *Meloidogyne spp*., are becoming a real threat to almost all vegetable crops and they have been considered as a limiting factor in crop production (Ibrahim, 2011).

Tomato (*Lycopersicon esculentum*, mill,) is of tropical American origin and belongs to family Solanacae. Like other vegetable crops tomato supports of a complex of pests: nematode, fungi, bacteria, and insects. These diseases attack the plant through roots, and the damage done by the nematodes can provide an avenue for these pathogens (Norling 2012). All the major species of *Meloidogyne* and their known races readily attack tomato crops indoor and outdoor cultivation. Root knot nematodes cause a high as 85% suppression in the yield of tomato (Gahai *et al.,* 2007).

The control of plant parasitic nematodes has been a difficult task for decades. Remarkable reduction of nematode population has been achieved by application of nematicides of chemical origin. However, due to the hazardous effects of chemical on the environment, great interest has focused on biological control methods. Several strategies, including resistance cultivars , organic soil amendments, and biological control have been developed for the management of plant parasitic nematodes (Wang *et al.,* 2004, and Kkemenju *et al.,* 2008). Evidence has been provided that integrating biological control using microbial antagonists with other feasible methods is amongst the most pragmatic strategies of managing the nematodes (Mostafa 2001, Kiewnick and Sicora 2005). Plant growth promoting rhizobacteria (PGPR) especially belonging to the genera *Pseudomonas* and *Bacillus* have demonstrated potential for disease suppression without negative effects on the user or environment, and hence they has a considerable agricultural value (Hamida *et al.,* 2011, Osman *et al.,* 2012, and Kavitha *et al.,* 2013).

Many studies emphasized that nematode population were greatly suppressed after compost application (Akhter and Malik 2000, Farahat *et al.,* 2010). The effect of composts on nematode populations may be due to the differences between the impact, materials used to reproduce compost, and compositing system as well (Litterick *et al.,* 2004).

The research approach of using inorganic fertilizer NPK to diminish nematode and maximize the benefits of fertilizers started in 1955 when Otiefa reported that ammonia decreased the counts of *M. incognita* females

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and egg masses produced on infected lima bean. Many reports discussed this subject (Bamel *et al.,* 2003, Kheir *et al.,* 2009, and Hoda *et al.,* 2013).

In view of using combination of inorganic fertilizer with either, organic amendments, bionematicides, or agrochemicals in integrated regimes limited literature was available.

This study was designed to assess: the protective value of combining either the commercial bioproduct Micronema which contains the two rhizobacteria *Bacillus spp*. and *Pseudomonas flourescnes*, compost as organic amendment or chemical nematicide Oxamyl(vaydate 24%) along with NPK as inorganic soil fertilizer in controlling root Knot nematode *Meloidogyne incognita* and their effects on the tomato yield production under field conditions

Materials and Methods

A field experiment was conducted during two successive seasons to study the effects of combining either Micronema , compost as organic fertilizer or Oxamyl along with NPK as inorganic soil fertilizer against *M. incognita* naturally infecting tomato cv.Castle Rock at Kafr Hakim region Giza governorate, Egypt. The experimental field was divided into plots each comprising rows of six m. long and 75cm apart and the distance between the plants were 50cm.The experiments were set up in a completely randomized block design with five treatments designed as shown in(Table 1) with 60 replicates (plants) for each reatment. Method and time of applications of all treatments are shown in (Table 1).

Table 1: Design of the experiment.

Treatments	Active ingredients	Concentration	Mode of application	Time of application	Source
Control (without any additive)					
NPK alone	20% N, 20% P, 20% K.	150 N unit/feddan	Soil treatment	At planting	Hamza company
Oxamyl+ NPK		Liquid 24%, 6cm/Liter	Foliar spraying.	Three times.15days between each one	Ministry of agriculture
Micronema+ NPK	*Bacillus sp.+ Pseudomonas fluorescent*	6 cm/Liter	Foliar spraying	Three times. First at transplanting, the second after two weeks, and the third after two weeks.	Ministry of agriculture
Compost+ NPK	100% plant waste	10 ton/feddan	Soil treatment	At transplanting time	Scientific company

Initial population densities of *M. incognita* were determined prior to planting time from 250g subsamples of well mixed soil from each row according to (Barker 1958). Four months later, at harvest time five plants were chosen at random from each row were carefully uprooted and tomato plants were hand harvested for yield estimation and the following data were recorded: number of root galls, and egg masses as well as *M. incognita* juveniles / one gram root. The final nematode soil populations were extracted as previously. The nematodes were counted and an average of three counts were taken to determine the final population densities of *M. incognita* juveniles in soil and expressed as nematodes/ kg soil. Data was subjected to analysis of variance and means were compared statistically according to Duncan. Percentage nematode reduction in soil determinate according to Handreson and Tilton formula (Puntener, 1981) as follows:

Nematode reduction (%) = [1 - PTA/ PTB× PCB / PCA] × 100, where:

PTA= population in the treated plot after application,

PTB= population in the treated plot before application,

PCB= population in the check plot before application,

PCA= population in the check plot after application.

Data of the second season were presented in (Table 3).

Results

The effects of combining inorganic fertilizer NPK and either Micronema, compost, or Oxamyl in controlling *M. incognita* infecting tomato plants under field conditions at two successive seasons were presented in (Tables 2&3). Recorded data showed that all tested products significantly reduced the final nematode population and improved yield production as compared to control untreated plants. The effects varied among treatments.

The potency of the tested products showed the following sequence as shown in (Table 2): first, it was evident that Oxamyl along with NPK treatment overwhelmed all other treatments in decreasing nematode final population and improving tomato yield production. The percent reduction were 81.5%, 16% ,and 34.3% ,for *M incognita* juveniles in soil, root galls, and egg masses respectively as compared to untreated control treatment.

Second: the application of the organic fertilizer NPK alone treatment resulted in 61.5%, 9.3%, and 41.2 %, decrease in *M. incognita* juvenile in soil, root galls, and egg masses respectively as compared to control untreated treatment. Third: the compost along with NPK, data recorded percentage reduction by 57.1%, 14.7%, and 24.7%, for *M. incognita* juvenile in soil, root galls, and egg masses respectively as compared to control untreated treatment. Fourth: the application of the bionematicide Micronema along with NPK treatment showed the lowest percentage reduction in the previous nematode development parameters. The percent reduction were 50.2%, 2.7%, and 6.9%, for *M. incognita* j_2 in soil, root galls and egg masses respectively as compared to control untreated treatment.

The above mentioned products significantly increased tomato yield production. Oxamyl along with NPK increased tomato yield by 47.7% as compared to untreated control, followed by compost along with NPK by 35.4% increase as compared to untreated control, while NPK alone exhibited 29.2% increase as compared to untreated control. The lowest percentage increase in tomato yield was recorded in Micronema along with NPK treatment. It was 10.8% increase as compared to control untreated.

The same trend in nematode population reduction and tomato yield production were observed in the the repeated field experiment for the second season (Table 3).

Table 2: Effects of combining inorganic fertilizer NPK and either Micronema, compost or Oxamyl in controlling Meloidogyne incognita infecting tomato plants under field conditions during the first season.

Treatments	No. of *M. incognita* J2 (1kg soil)			No. of galls (5g roots)		No. of egg masses (5g roots)		Tomato yield	
	Initial	Final	% decrease	No.	% decrease	No.	% decrease	Tons/ feddan	% increase
Control	2930	12092 a	-	75 a	-	73 a	-	32.5 b	-
Chemical fertilizer NPK	2800	4444 b	61.5	68 b	9.3	43 c	41.2	42.0 a	29.2
Oxamyl +NPK	2950	2248 b	81.5	63 c	16.0	48 bc	34.3	48.0 a	47.7
Micronema+NPK	2750	5648 b	50.2	77 a	2.7	68 a	6.9	36.0 b	10. 8
Compost+ NPK	2800	4960 b	57.1	66 c	14.7	55 b	24.7	44.0 ab	35.4

**Percentage decrease in M. incognita in soil according to Handerson& Tilton formula (Puntener 1981).*
***The mean difference is significant at P≤ 0.01 level.*

Table 3: Effects of combining inorganic fertilizer NPK and either Micronema, compost or Oxamyl in controlling Meloidogyne incognita infecting tomato plants under field conditions during the second season.

Treatment	No. of *M.incognita* J2 (1kg soil)			No. of galls (5g roots)		No. of egg masses (5g roots)		Tomato yield	
	Initial	Final	% decrease	No.	% decrease	No.	% decrease	Tons/ feddan	% increase
Control	2900	13504a	-	77 a	-	73 a	-	34 b	-
Chemical fertilizer NPK	2950	3796 b	72.3	68 b	10.2	44 d	39.7	44 ab	29.4
Vaydate +NPK	2850	2408 b	81.9	63 c	18.2	48 d	34.3	50 a	47.1
Micronema+NPK	2930	5760 b	57.8	74 a	3.9	67 b	8.2	38 b	11.8
Compost+NPK	3000	4652 b	66.7	63 c	18.2	54 c	26.0	46 b	35.3

**Percentage decrease in M. incognita in soil according to Handerson& Tilton formula (Puntener, 1981).*
***The mean difference is significant at P≤ 0.01 level.*

Discussion

This study demonstrated that NPK as soil inorganic fertilizer integrated with compost (organic soil amendment) can be used in the management of plant parasitic nematode *M. incognita* infecting tomato plants. Our results are in harmony with the findings of (Farahat *et al.,* 2010) who found that combination of compost with commercial NPK treatment was effective in controlling *M. incognita* and improving tomato yield. The impact of organic amendments has been documented by (Langat *et al.,* 2008). While incorporation of organic amendments has been shown to be detrimental to plant parasitic nematodes (Wang *et al.,* 2004) due to release of NH^4 , formaldehyde, phenol , and volatile fatty acids. It was generally postulated that the adverse influence of organic amendment on parasitic nematode is referred to increasing host resistance to nematode infection and enhancement of growth performance (Countray and Millon, 2008). Compost improves cataion exchange, provides humus, vitamins, hormones, plant enzymes which not supplied by chemical fertilizers (Field guide to compost use 2001). Moreover, the dual effects of NPK in improving plant growth and suppressive nematode population is documented by (Akhtar and Mohamed 1996, Sinah and Neog 2003).

Concerning the bionematicides micronema along with NPK treatment, our results showed its potential in suppressing J_2 in soil by 50.2% and increased tomato yield by 112.5%. These results are in agreement with (Wepuhkhulu *et al.,* 2011, and Hoda *et al.,* 2013) who found that, application of *Bacillus spp*., significantly reduced hatching of *Meliodogyne javanica* root knot. Among the bionematicide Micronema, the plant growth promoting bacteria (PGPR), *Pseudomonas* and *Bacillus*. The reduction of plant parasitic nematodes associated with *B. subtilus* may be attributed to diverse mechanisms which involve phytohormones production, reduction

of the activity of hatching factors, alteration of the exudates and inhibition of nematode penetration into the roots thereby interfering with host finding process and reducing galls (Karanja *et al.,* 2007). Chemotaxis towards exudte components has also been regarded as an important trait for root colonization (De weert *et al.,* 2002). Improving plant growth by solubilizing phosphate and other nutrient and making them available to the plant (Broadbent *et al.,* 1977 and Hamida *et al.,* 2011).

Surprisingly Micronema along with NPK treatment exhibited the lowest reduction in *M. incognita* J2 in soil by 50.2% and the lowest increase in tomato yield by 112.5% comparing this result by NPK treatment alone it was found that NPK recorded 61.5% percent reduction for *M. incognita* J2 in soil and 129.6% percent increase in yield production. This result may be attributed to the incompatibility of the biological control agents and the inorganic fertilizer. The successful management of plant parasitic nematodes, keeping the population below economic threshold levels, depending on the compatibility between the biological agents and the complex environment of soil. According to Walker, (2004) and Wang *et al.,* (2003), biological control of nematodes has mainly been achieved by conservation of existing biological agents and building of beneficial organism through the use of various soil amendment.

In spite of our finding that Oxamyl along with NPK overwhelmed all the treatments in controlling nematode and increasing tomato yield, the authors recommend further studies about agrochemicals integrated regimes.

It was concluded that root knot nematodes infecting tomato plants can be maintained below harmful thresholds through integrated application of inorganic fertilizer such as NPK combined with organic amendments such as compost.

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