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MANAGEMENT OF *Meloidogyne incognita* ON TOMATO BY FOLIAR SPRAYING AMMONIA OR ADDING OLD FARMYARD MANURE, OR *Bacillus thuringiensis* AS SOIL AMENDMENTS UNDER WIREHOUSE CONDITIONS.

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ABSTRACT

Wire house experiment was conducted to study the impact of three components i.e. protecto, *Bacillus thuringiensis* (Bt), farmyard manure (FYM) and ammonia at two levels of application each as 0.9& 1.8 g, 42& 63 g; and 30& 60 ml/plant separately where the first two components applied as soil amendments whilst the third one as foliar spraying comparing to oxamyl at the recommended dose on controlling *M. incognita* infecting tomato cv. 888 or not and plant growth as well under greenhouse conditions during spring seasons of 2011& 2012. Results showed that all tested treatments ameliorated plant growth criteria of the infected and uninfected ones comparing to the checks. Moreover, as the level of farmyard manure and ammonia raised from 42 to 63 g for the former and from 30 to 60 ml/plant separately for the latter as tomato plant height, total plant fresh weight, shoot dry weight, leaves dry matter, total yield of tomato fruit, diameter and number percentage increase values increased for both plant cases of seasons 2011& 2012, respectively comparing to the checks. However, opposite results were recorded within treatment of protecto (Bt) levels. Among the three components with two levels each tested, ammonia at 60 ml/plant as foliar spraying application accomplished the highest percentage increase values that averaged 89.92& 70.2%, 68.9% &59.53%; and 89.7& 75.3%, 75.34& 65.9%; 59.4& 61.1%; 71.1& 51.2%; and 128.9& 132.8%, 90.3& 101.6%; and 90.4& 97.26% for plant height, total plant fresh weight, shoot dry weight, leaves dry matter, total yield tomato fruit, diameter and number for the uninfected plants of two tested seasons 2011& 2012, respectively. Similar trend was observed with the infected plants, where ammonia at 60 ml/plant also surpassed other tested treatments with values that were amounted to 70.68 and 65.44%; 84.0& 75.25%, 124.2& 119.7%; 70.7& 118.4%; 83.8& 62.8%; for the same tomato plant growth characters, respectively comparing to nematode alone for the two seasons 2011& 2012. However, plant receiving protecto (Bt) at the high level (1.8 g/plant) recorded the least values of plant height, total plant fresh weight; shoot dry weight, leaves dry matter, total yield of tomato fruit, and diameter, number, respectively for seasons 2011& 2012 of the infected and uninfected plants.

Keywords: Control, *Meloidogyne incognita* protecto, *Bacillus thuringiensis* (B.t.), farmyard manure (FYM), ammonia, tomato, Oxamyl.

INTRODUCTION

Tomato *(Solanum lycopersicon* Mill.*)* is one of the most important vegetables crops in the Egyptian Agriculture cultivated in over 538038 feddans with a production of about 9087657 tones in 2009/2010 (FAO, 2010) and it is a major component of daily meals in many countries and constitutes an excellent source of health-promoting compounds due to the balanced mixture of minerals and antioxidants including ascorbic acid, vitamin E, lycopene, beta-carotene, xanthopyll and flavonoides. Lycopene, the predominant carotenoid in tomatoes, is hypothesized to mainly mediate the health benefits of tomato products. Anticancer activity of tomato products and lycopene has been suggested by numerous scientists in this respect. In view of the enormity of the yield losses caused by root-knot nematodes to tomato crop, it is necessary to minimize crop damage by adopting appropriate management methods available. Application of chemical nematicides does not always prove effective and economic (Pakeerathan *et al.*, 2009). In addition, poor target specificity of chemicals pose environmental and human toxicity hazards (Barker and Koenning, 1998). Therefore, environmentally friendly alternatives are required for nematode control. Biological control is one possible safe alternative to pesticides for disease management, and is likely to be free from toxic residual effects. There are numerous microbial antagonists of root-knot nematodes and their application resulting in significant decrease in the nematode populations (Khan, 2007). Therefore, the main of this present work is to study management of *Meloidogyne incognita* on tomato by foliar spraying ammonia or adding certain soil amendments during spring seasons 2011& 2012 under greenhouse conditions.

MATERIALS AND METHODS

Two pot experiments were carried out in the greenhouse of Nematology Research Unit, Agricultural Zoology Department, (NERU), Fac. Agric., Mansoura University Egypt, during spring seasons of 2011 and 2012 to study the response of tomato plant *(Solanum lycopersicon* Mill.*)* cv. 888 to ammonia solution, farmyard manure (FYM) and bio chemical product protecto (*B. thuringiensis*) under the stress of *Meloidogyne incognita* infection or not.

The experimental soil analysis:

Soil samples were taken before planting from experimental soil to determine the physical and chemical analysis. The obtained results are shown in Table (1):

Table (1): Physical and chemical properties of experimental soil (average two seasons). (Jackson, (1967).

Mechanical analysis %					pH	Ec	$CaCO_3$	OM	Avail. ppm		
Cores sand	Fine Sand	Silt	Clay	Texture class	1:2.5	1:5 ds/m	%	%	N	P	K
1.66	26.3	32.4	39.6	Clay loamy	8.12	0.93	2.66	0.83	54.6	4.8	325

Source of nematodes and preparation of *Meloidogyne incognita* eggs as nematode inoculum:

The root-knot nematode, *M. incognita* culture was initiated by single eggmass of previously identified females (Talyor *et al.,* 1955) and isolated from galled roots of highly infected tomatoes collected from Mansoura, Dakahlia governorate, Egypt and propagated on coleus plants, (*Coleus blumei*) plants in the greenhouse of, Agricultural Zoology Department , Fac. Agric., Mansoura University , where this work was done. Nematode inoculum of *M. incognita* eggs was then prepared according to the method recorded by Hussey and Barker, (1973).

Pesticide: Oxamyl: (Vydate 10% G.) Methyle – N– N– dimethyl – (N (methyl) carbomycocyl) - 1- Thioxamidate.

Impact of adding old farmyard manure, *Bacillus thuringiensis* as soil amendments and foliar spraying ammonia on controlling *Meloidogyne incognita* infecting tomato plants in comparison with oxamyl under greenhouse conditions.

In order to study the effect of adding old FYM, *Bacillus thuringiensis* (Bt) and ammonia (foliar spraying) at two levels each, i.e. 42 and 63 g/plastic bags, 0.9 and 1.8 g/plastic bags and 30 and 60 ml/l as foliar spray respectively in comparison with oxamyl at the recommended dose (0.9 ml/plant) on controlling *M. incognita* infecting tomato plants cv. 888 under greenhouse conditions, from April 4th , 2011 up to June 10th 2011 for the first spring season and from April 10th 2012 up to June 14th 2012 for the second spring season. One hundred and thirty five plastic bags (with four pores, two at each side), were filled with 3 kg steam-sterilized clay loamy soil, thirty six plastic bags out of them received the FYM then irrigated with tap water and left one week for decomposition. After that one hundred and thirty five tomato seedlings were transplanting to all plastic bags seedling (one/bag) and nematode inoculum at the level of 4000 eggs of *M. incognita* was separately introduced to seventy two tomato seedlings at the rate of nine replicates per treatment including nine seedlings for oxamyl treatment and nine seedlings for nematode alone without any treatment. For each level tested components, nine seedlings one/bag left unionculated with nematode to serve as check. Tested treatments of protecto (Bt), ammonia and oxamyl was separately applied one week after nematode inoculation.

This experiment included 15 treatment as follows:

1- N + FYM (42 g/plant),
2- FYM (42 g/plant),
3- N + FYM (63 g/plant),
4- FYM (63 g/plant),
5- N + Ammonia (30 ml/l/plant),
6- Ammonia (30 ml/l/plant),
7- N + Ammonia (60 ml/l/plant),
8- Ammonia (60 ml/l/plant),
9- N + B.t (0.9 g/plant),
10- B.t (0.9 g/plant),
11- N + B.t (1.8 g/plant),
12- B.t (1.8 g/plant),
13- N + Oxamyl (0.9 g/plant),
14- N alone and
15- Plant free of N and any tested components

These treatment were arranged in complete randomize block design with nine replicates on a greenhouse bench at each spring season. Plants received water, foliar spraying of NPK recommended and protected by conventional pesticides against mites and insects as needed. Plants were harvested after 60 days from nematode inoculation. Infected tomato roots for each level of tested components per replicate, oxamyl and nematode alone were separately washed in tap water, fixed in formalin for 48 hr and then stained in acid fuschin in lactic acid (Byrd, *et al.*, 1983), washed in tap water and placed in pure cold glycerin and examined with stereoscopic microscope for counting the numbers of galls, eggmasses, developmental stages and females for *M. incognita* and recorded. *M. incognita* (j_2) were extracted from soil through sieving and modified Baermann technique (Goodey, 1957), counted and recorded.

Data recorded:

1. Vegetative growth:

Nine plants from each treatment were randomly taken at 60 days after transplanting during the seasons of 2011 and 2012 and the following data were recorded:

- Plant height (shoot +root)
- Root fresh weight /g
- Number of leaves/plant
- Leaves dry matter

Leaves of plant samples were separated; weight and oven dried at 70°c till constant weight was reached. The dry weight of leaves as gram per plant was calculated. The dried leaves were thoroughly ground and stored for chemical analysis.

2. Flowering parameters:

Nine plants of each treatment were randomly chosen and marked and the following data were recorded:

- Number of fruits per plant
- D.M. of fruits

3- Fruit yield and its components:

At harvesting time after 60 days after nematode inoculation, the following data were recorded:

- Number of fruits /plant
- Average fruit weight; gram/plant
- Total fruit Yield; gram per plant

Statistical analysis:

Statistically, the obtained data were subjected to analysis of variance (ANOVA) (Gomez and Gomez, 1984) followed by Duncan's multiple range tests to compare means (Duncan, 1955).

RESULTS AND DISCUSSION

Data in Table (2) illustrate the influence of three components i.e. protecto (Bt) *Bacillus thuringiensis*, farmyard manure (FYM), and ammonia at two levels of applications each as 0.9& 1.8 g/plant, 42& 63 g/plant and 30& 60 ml/plant where the first two applied as soil amendments whilst the third one as foliar spraying comparing to oxamyl on controlling *Meloidogyne incognita* infecting tomato plants cv. 888 and plant growth as well under greenhouse condition during 1st and the 2nd seasons, 2011& 2012. Results indicated that the tested treatments had more or less effects on growth of tomato plants infected with nematodes or not as well. Moreover, all treatments ameliorated plant growth criteria of the infected and uninfected ones comparing to the checks. For example, plant receiving protecto (Bt) at the level of 1.8 g/plant recorded lesser values of tomato plant height (21.44%) and(27.73%), total fresh weight of plant (17.7% and 15.13%), than that of 0.9 g/plant for the 1st and 2nd seasons of 2011 and 2012 within the infected comparing to nematode alone. Moreover, an opposite trend was recorded for the uninfected plants for the same treatments that averaged 37.68& 47.82% for plant height with the high level of protecto (Bt) (1.8 g/plant) comparing to the check. Meanwhile, it is interesting to observe that as the level of such application increased from 42 to 63 g/plant of FYM and from 30 to 60 ml/plant of ammonia, as tomato plant growth characters percentage tested increased for both cases of infected and uninfected plants. Among the tested three components at two levels each, ammonia at high level ranked first in improving plant growth parameters with values of 70.68 and 65.44%; and 84.0, 75.25%, for plant height, and total plant fresh weight, for the two seasons for the infected plants respectively. Moreover, plant receiving ammonia 30 ml/plant ranked second to that of ammonia 60 ml/plant percentage increase values of the same plant growth characters that averaged 61.07 and 56.13; and 72.17, 65.07%, for the same season respectively followed by FYM 63 g/plant, protecto (Bt) 0.9 g/plant and FYM 42 g/plant treatments, respectively comparing to nematode alone. Similar trend was recorded for the percentage increase values of the same plant growth criteria within the uninfected plants with higher values in all plant growth criteria tested, especially for the 2nd season. Oxamyl as a systemic nematicide accomplished high percentage increase value of plant growth parameters equal to that of ammonia at high level 60 ml/plant in most cases that averaged 70.68& 65.44%; and 70.03& 68.55%, for plant height, total plant fresh weight, respectively. While those of oxamyl were amounted to 64.02, 57.3%; and 70.03 and 68.55% respectively (Table 2). Likewise, ammonia at 60 ml/plant the high level as well as the low one accomplished the highest percentage increase values of 87.52& 70.2%, 68.9& 59.53%; and 89.7& 75.3%; 75.34& 65.9% for plant height and total plant fresh weight of the uninfected plants for the two seasons 2011& 2012, respectively comparing to the check (Table 2).

Data presented in Table (3) reveal the effect of three components, i.e protecto (Bt) (0.9& 1.8 g/plant); farmyard manure (42&63 g/plant) as soil amendments and ammonia (30&60 ml/plant) as foliar spraying application in comparison with oxamyl on growth of tomato plants cv. 888 infected with *M. incognita* or not under greenhouse conditions during the seasons of 2011& 2012. Results indicated that all tested treatments improved plant growth parameters i.e. shoot dry weight& leaves dry matter of the infected and uninfected plants to great extent. It is interesting to notice that as the levels of farmyard manure and ammonia increased from 42 to 63 g/plant for the first and from 30 to 60 ml/plant for ammonia as tomato plant growth parameters percentage increase values increased, whereas the low level of protecto (Bt) at 0.9 g/plant gave much better results in this respect than that of 1.8 g/plant the high level of protecto (Bt) comparing to nematode alone. Among the tested components, ammonia at 60 ml/plant (the high level) as foliar spray application surpassed other tested treatments in the increment percentage increase values of 57.76& 52.35%; and 49.14& 40.63% for shoot dry weight and leaves dry matter of the infected plants for the two seasons 2011& 2012, respectively comparing to nematode alone (Table 3). Likewise the same trend was noticed in the case of the uninfected plants for the two seasons with the same plant growth criteria which were amounted to 59.4& 61.1%; and 71.1& 51.2% respectively comparing to the check. Moreover, plant receiving ammonia 30 ml/plant ranked third to that of 60 ml/plant in percentage increase values of plant shoot dry weight (49.04& 44.03%); and (50.2& 60.9%); 49.64& 47.99%; and 52.9& 50.0%) for the infected and uninfected plants of the two seasons 2011& 2012, respectively (Table 3). Moreover, oxamyl as a systemic nematicide ranked second to ammonia 60 ml/plant the (high level) in improving such tomato plant growth parameters with values of 51.76& 52.35%; and 49.4 & 40.63% for plant shoot dry weight and leaves dry matter of the infected plants of the two tested seasons(Table 3).

Data in Table (4) reveal the effect of three components i.e. protecto (Bt), farmyard manure at two levels each as soil amendments and ammonia at 30& 60 ml/plant as foliar spray application comparing to oxamyl at the recommended dose on tomato plants cv. 888 fruit number, diameter and total yield under the stress of *M. incognita* infection or not in the greenhouse condition during spring seasons of 2011& 2012. Results indicated that tested tomato fruit characters showed high values with the uninfected plants more than the infected ones comparing to the check of each, respectively. Moreover, plant receiving ammonia at the two levels tested in both plant cases surpassed other treatments in total yield of tomato fruits, diameter and number with percentage increase values that averaged 111.6& 124.2; 109.6& 119.7%; 61.1& 70.7; 95.9& 118.4%; and 73.5& 83.8; 56.9& 62.8% for the infected plants of the two spring seasons respectively comparing to nematode alone (Table 4). However, plant treated by protecto (Bt) at high level (1.8 g/plant) gained the least percentage increase values of the same fruit criteria that averaged 30.8, 21.4 and 59.5%; and 14.4, 44.8, and 57.6% for the two spring seasons 2011& 2012 comparing to nematode alone, respectively. Meanwhile, the moderately percentage increase values of total yield tomato fruits diameter and number of the infected plants for the two seasons were recorded by farmyard manure at high and low levels and protecto (Bt) at low level as well of the infected plants within the two spring seasons (Table 4).

For instance, farmyard manure at high level (63 g/plant) showed percentage increase values of 76.3& 73.5%; 55.7& 90.2%; and 67.8& 41.2% for total yield of tomato fruit, diameter and number, respectively whereas the low level of protecto (Bt) 0.9 g/plant recorded values of 84.2& 80.8%, 40.4& 48.9%; and 51.1& 69.8%, for the same tomato fruit characters within the two seasons 2011& 2012 of the infected plants, respectively comparing nematode alone (Table 4). Oxamyl as a systemic nematicide ranked second to ammonia at the high level with values of 115.4& 116.3%, 63.9& 113.9%; and 76.6& 52.9%, for the same fruit criteria, respectively. Meanwhile, similar trend was observed with the uninfected plants for the same tomato fruits parameters where ammonia at high level (60 ml/plant) accomplished the highest percentage increase values of 128.9& 132.8%, 90.3& 101.6%; and 90.4& 97.26% for total yield, diameter number tomato fruits of the two seasons over other tested treatments in the uninfected and infected plants as well, respectively (Table 4). It is interesting to note that most tomato fruit characters values was high in the second season 2012 more than that of the 1st season 2011.

Data as depicted in Table (5) verify that all tested components i.e. protecto (Bt), farmyard manure (FYM) and ammonia at the level of 0.9& 1.8 g/plant; 42& 63g/plant and 30&60 ml/plant, respectively as soil applications for the first two components and foliar spraying for the latter treatments to tomato seedlings cv. 888 infected with *M. incognita* were significantly effective in reducing numbers of formed galls, juveniles recorded from soil, the embedded stages as measured by the developmental stages, eggmasses, final population and the subsequence calculated reproduction rate when compared with those of the inoculated untreated cheek of the 1st

season 2011. It is interesting to observe that as the level of such tested components increased as percentage reduction values of such nematode criteria increased. For instance, plant receiving protecto (Bt) 1.8 g/plant accomplished reduction percentage values of *M. incognita* parameters on tomato plants much better than that of 0.9 g/plant, comparing to the check (Table 5). Meanwhile, among the components tested ammonia 30 or 60 ml/plant as foliar spray applications were the ultimate efficacious treatments performing crucial reduction in final nematode population by 96.3& 96.8% respectively, followed by that of farmyard manure (63 g/plant) with value of 96.1% respectively comparing to nematode alone (Table 5).

Moreover, the modest reduction percentage values of these nematode parameters resulted by farmyard manure at low dose (42 g/plant) as soil organic amendment treatment that averaged 93.2% for final nematode population, respectively comparing to nematode alone. Oxamyl as a systematic nematicide surpassed all bio-components tested and ranked first in reducing nematode parameters on tomato plants with value of 97.0% for final nematode population (Table 5). Accordingly, the nematode reproduction was also affected by the tested bio-components performing the above mentioned trend. Such rate of nematode reproduction folded 1.788 times in the check treatment, whilst its multiplication rates was restricted between 0.295 to 0.271; 0.121 to 0.070; and 0.067 to 0.057 Vs 1.788 (nematode alone) for protecto, farmyard manures, ammonia levels applications, where ammonia 60 and protecto (Bt) 0.9 g/plant treatments represented of minimum and maximum values of such applications studied respectively. Moreover, the regression analysis between rate of nematode reproduction and tested components applications gave R^2 value of 0.2032 (Fig. 1). Promising results were also reported among tested bio-components in such applications used, where the indices of root galls and eggmasses number as well showed the lowest values that were accomplished by protecto (Bt) (1.8 g/plant) (3&3) farmyard manures (42& 63 g/plant) (3&3) and that of ammonia (30&60 ml/plant) (3&2) (3&2) Vs 5&5 for nematode alone, respectively (Table 5).

Data in Table (6) verify that all tested components i.e. protecto (Bt), farmyard manure (FYM) and ammonia at the level of 0.9& 1.8 g/plant, 42& 63 g/plant and 30& 60 ml/plant, respectively as soil applications for the first two bio-agents and as foliar spraying for the third treatment to tomato seedling cv. 888 infected with *M. incognita* were significantly effective in reducing numbers of formed galls, juveniles recorded from soil, the embedded stages as measured by developmental stages, eggmasses, final population and subsequence calculated reproduction rate when compared with those of the inoculated untreated check of the 2nd season 2012. Moreover, it was noticed as the dose of such tested components increased as percentage reduction values of any nematode parameter increased. For example, plant treated with protecto (Bt) 1.8 g/plant as bio-agent accomplished reduction percentage values of *M. incognita* criteria on tomato plants more higher than that of 0.9 g/plant comparing to the check (Table 6). Meanwhile, among the tested components, ammonia 30 and 60 ml/plant as foliar spray applications were the ultimate efficacious treatments performing crucial reduction in final nematode population by 96.2& 96.6% respectively followed by that of farmyard manure (63 g/plant) with value of 96.2% for the same nematode criterion, respectively (Table 6). Moreover, the modest reduction percentage values of the tested nematode parameters resulted by farmyard manure at 42 g/plant the low level as soil organic amendment treatment that averaged 93.2% final nematode population, respectively (Table 6), whereas, the lowest values of this tested nematode criterion were recorded by protecto (Bt) 0.9 g/plant that averaged 83.6% respectively. Oxamyl as a systemic nematicide surpassed all tested components and ranked first in diminishing nematode criterion on tomato plants with values of 97.2% for final nematode population, respectively. Accordingly, the nematode reproduction factor (RF) was also effected by the tested components performing the above mentioned trend. Such rate of nematode reproduction folded 1.799 times in the check treatment, whereas its multiplication rates was restricted between 0.295 to 0.270, 0.122 to 0.068 and 0.068 to 0.061 Vs 1.799 (nematode alone) for protecto (Bt), farmyard manure and ammonia at two levels, respectively, where protecto (Bt) 0.9 g/plant and ammonia 60 ml/plant treatments and represented of maximum and minimum values of such applications studied, respectively. Moreover, the regression analysis between rate of nematode reproduction and tested components applications gave R^2 value of 0.2043 (Fig.2).

Promising results were also recorded among tested components in such treatments used, where the indices of root galls and eggmasses number as well showed the lowest values that were achieved by ammonia 60 ml/plant (3&2), protecto 1.8 g/plant (3&3), FYM (42& 63 g/plant) (3&3) and protecto 1.8 g/plant (3&3) whereas protecto 0.9 g/plant had values of (4) for root gall and (3) for eggmasses VS 5&5 for nematode alone, respectively (Table 6).

Apparently, results of the present study firstly indicated that as the level of such applications increased from 42 to 63 g/plant of farmyard manure or from 30 to 60 ml/plant of ammonia, as tomato plant growth characters percentage i.e. plant height, total plant fresh weight increased for both cases of infected and uninfected plants, of the two spring seasons 2011& 2012, respectively. These findings are in agreement with those reported by El-Ghamrey and El-Naggar (2001), Youssef *et al.,* (2001) and Rai (2006) who said that organic manures improve retention in the soil and are good source of essential nutrients as well they beneficially affect microflora activities, improve soil structure and decrease soil pH after cultivation as well as that of Naidu *et al.,* (2001) in respect to the use of 20 tons farmyard manure plus NPK (100+50+50 kg)/ha gave significantly maximum plant height, number of leaves per plant and yield. Moreover, the simulative effect of ammonia at 60 ml/plant as foliar spraying on improving tomato plant height and total plant fresh weight in this study are also in agreement with the findings of kumara *et al.,* 2003; Kall, (2004); Gandahi and Qad, 2005, and Azouz and Salim, 2007 who reported that foliar application of urea, superphosphate and microelement increased vegetative characteristics traits of sunflower at 65 days from planting.

As for the effect of three components i.e. protecto B.t., farmyard manure as soil amendments and ammonia as foliar spraying application at two level each in comparison with oxamyl on growth of tomato plants cv. 888

infected with *M. incognita* or not under greenhouse conditions during the seasons of 2011& 2012, ammonia at 60 ml/per plant (the high level) surpassed other tested treatments in the increment percentage increase values of shoot dry weight and leave dry matter of the infected and uninfected plants of two spring seasons 2011& 2012. followed by that of farmyard manure at 63 g/plant as soil amendments in this respect. These present results are in agreement with those reported by Togun and Akanbi (2003) in respect to the organic based fertilizer (OBF) on tomato that was highly effective on crop performance and significantly increased plant dry matter by 29.6% and that of El-Kady *et al.,* (2010) who reported that plant height, leaf area and dry matter/plant of sunflower were significantly affected by nitrogen fertilizer rates 30 kg/fed and foliar sprays urea (2%) single superphosphate (4%) and a mixture of micronutrients on sunflower.

Concerning total yield of tomato fruits, its diameter and number as influenced by the same previous treatments, plant receiving ammonia at the two levels tested in both plant cases surpassed other tested treatments followed by that of farmyard manure applications in this respect. These findings of the present study were supported by several workers who came to similar results as reported by Naidu *et al.,* (2001), Krishna& Krishnappa (2002) and Mohd *et al.,* (2002) who stated that the application of organic farmyard manure with or without inorganic fertilizer resulted in the maximum plant height, number of tomato fruit per plant, yield and high quality and that of Hammad *et al.,* (2008) in respect to increasing rates of farmyard manure from 0 up to 20 m^3/fed, K fertilizer levels from 0 up to 100 kg/fed and inoculation of silicate bacteria (*Bacillus circulans*) markedly increased tuber yield (ton/fed) of potato plants.

As for *M. incognita* parameters as influenced by the six treatments tested in comparison with oxamyl at the recommended dose on tomato plants cv. 888 of spring seasons 2011& 2012 under greenhouse conditions, results revealed that as the level of protecto (Bt), farmyard manure as soil amendments applications and ammonia as foliar spraying treatments raised from 0.9 to 1.8 g/plant and 42 to 63 g/plant for the two former and from 30 to 60 ml/plant for the latter as percentage reduction values of such nematode criteria tested increased. Ammonia at 60 ml/plant application was also the ultimate efficacious treatment performing crucial reduction in final nematode population by 96.3& 96.6% respectively followed by farmyard manure (63 g/plant) by 96.1& 96.2% and then (Bt) at 1.8 g/plant by 84.9& 84.9% for two spring seasons 2011& 2012 respectively comparing to nematode alone. These results of the present study were supported by the findings of Akhtar and Mahmood (1997) in request to application of poultry and cattle manure, inorganic fertilizer in the form of urea that significantly reduced populations of *M. incognita* and observed that higher dosages resulted in greater effects.

Undoubtedly, the biotic (Bt) and a biotic (farmyard manure and ammonia) factors tested at two levels each in the present study as tool for improving tomato cv. 888 plant growth and production under the stress of *M. incognita* infection or not in comparison with oxamyl at the recommended dose succeeded to generate a sort of inducing resistance in a susceptible host plant against such pathogenic nematode since protecto (Bt) 1.8 g/plant, 63 g/plant farmyard manure as soil amendments and ammonia at 60 ml/plant as foliar spraying applications represented the maximum reduction percentage values of root galling 95.5& 95.2%; 95.8& 96.4%; 97.0& 98.3%, female 96.6& 98.1%; 96.6& 96.7%; 97.8& 98.1% and eggmasses 96.6& 96.5%; 96.5& 96.7%, 98.2& 98.1% and final nematode population 84.9& 84.9%; 96.1& 96.1%; 96.8& 96.6% as well as the maximum increment percentage increase values of plant growth parameters such as yield of tomato fruits etc. Meanwhile, the nematicidal activities of the tested; and the biotic agents, farmyard manure and ammonia a biotic agent, Bt as soil amendments as well as their thermostable toxin in controlling on *M. incognita* on tomato root of both seasons 2011& 2012 can varied from component to another. These variations may be attributed to the differences in the chemical nature, compound present in these tested materials and method of application used. The safely of such materials and its low cost is one of its advantages.

Undoubtedly, organic manures are well established to be involved in fertilization in almost worldwide due to their beneficial effects on the physio-chemical and biological characteristics of soil which in turn influence the growth and increase plants production. However, results of this investigation summarized that ammonia at 60 ml/plant as foliar spraying application was superior over other tested treatments within the two spring seasons 2011, 2012 in improving tomato plant growth and production criteria and in diminishing nematode parameters as well. That is because foliar fertilization is more economical than root fertilization due to the efficiency and lower cost.

However, more research is needed in this direction under field conditions before drawing such recommendation for this new trend.

Table (2): Effect of three components at two levels on tomato cv. 888 plant growth under the stress of *Meloidogyne incognita* infection or not under wire house conditions during the seasons of 2011 and 2012.

Characters / Treatments	**Plant growth parameters							
	1st Season				2nd Season			
	Plant height	Inc.%	Total F.Wt	%Inc.	Plant height	Inc.%	Total F.Wt	%Inc.
INFECTED								
Protecto 0.9 +N	44.18 l	40.27	83.62 k	35.96	45.07 l	43.85	82.87 k	36.63
Protecto 1.8+N	38.25 n	21.44	72.39 m	17.70	40.02 n	27.73	69.83 m	15.13
FYM 42+N	42.27 m	34.19	80.00 l	30.08	43.82 m	39.86	78.97 l	30.21
FYM 63+N	49.06 i	55.77	92.86 h	50.99	49.67 i	58.53	98.08 h	61.71
Ammonia 30+N	50.73 e	61.07	96.02 e	56.13	53.94 e	72.16	100.12 e	65.07
Ammonia 60+N	53.76 c	70.68	101.75 c	65.44	57.68 c	84.10	106.29 c	75.25
Oxamyl+ N	51.66 d	64.025	97.77 d	57.30	53.27 d	70.03	102.23 d	68.55
N alone	31.50 o	----	61.50 n	----	31.33 o	----	60.65 n	-----
UNINFECTED								
Protecto 0.9	50.49 f	43.47	95.55 f	46.77	52.46 f	52.05	100.8 f	53.42
Protecto 1.8	48.45 j	37.68	91.69 i	40.84	51.00 j	47.82	54.25 i	-17.42
FYM 42	47.46 g	34.86	89.82 g	37.97	52.37 g	51.79	94.52 g	43.86
FYM 63	50.05 k	42.22	94.73 j	45.51	54.71 k	58.57	99.12 j	50.86
Ammonia 30	59.87 b	70.2	103.86 b	59.53	60.49 b	75.3	109.41 b	65.9
Ammonia 60	65.99 a	87.52	109.96 a	68.9	65.46 a	89.7	115.2 a	75.34
Plant free	35.19 h	----	65.10 o	----	34.50 h	-----	65.70 o	-----
L.S.D 5%	0.074	----	0.049	----	0.068	----	0.047	----

N= 4000 eggs of *M. incognita*

** Each value is the mean of nine replicates.
Means in each column followed by the same letter (s) did not differ at P<0.05 according to Duncan multiple- rage test

Table (3): Effect of three components at two level each on tomato plant cv. 888 shoot dry weight and leaves dry matter as influenced with *Meloidogyne incognita* infection or not under wire house conditions during the seasons of 2011 and 2012.

Characters	**Plant growth parameters							
	1st Season				2nd Season			
	Shoot D.Wt	%Inc.	Leaves dry matter	%Inc.	Shoot D.Wt	%Inc.	Leaves dry matter	%Inc.
INFECTED								
Protecto 0.9 +N	16.23 k	29.84	11.08 k	30.35	15.68 k	21.55	12.21 k	32.28
Protecto 0.18+N	14.01 m	12.41	9.59 m	12.82	13.98 m	8.37	10. 5 m	13.75
FYM 42+N	15.52 l	24.16	10.61 l	24.70	15.58 l	20.77	11.25 l	21.88
FYM 63+N	18.02 h	44.16	12.31 h	44.82	17.91 h	38.83	12.56 h	36.07
Ammonia 30+N	18.63 e	49.04	12.72 e	49.64	18.58 e	44.03	13.66 e	47.99
Ammonia 60+N	19.74 c	57.92	13.48 c	58.58	20.12 c	55.96	13.89 c	50.48
Oxamyl+ N	18.97 d	51.76	12.95 d	52.35	19.24 d	49.14	12.98 d	40.63
N alone	12.50 n	----	8.51 n	----	12.9 n	-----	9.23 n	-----
UNINFECTED								
Protecto 0.9	18.54 f	43.4	12.66 f	40.7	19.33 f	46.4	12.86 f	36.7
Protecto 0.18	17.79 i	37.9	12.15 i	35.0	15.63 i	18.4	12.15 i	27.9
FYM 42	18.38 g	42.5	11.90 g	32.2	17.98 g	36.2	12.21 g	28.5
FYM 63	17.43 j	35.1	12.55 j	39.4	18.12 j	37.3	13.21 j	39.1
Ammonia 100	20.15 b	56.2	13.76 b	52.9	21.25 b	60.9	14.25 b	50.0
Ammonia 200	20.56 a	59.4	14.50 a	61.1	22.58 a	71.1	14.36 a	51.2
Plant free	12.90 h	----	9.0 o	----	13.20 o	----	9.5 h	----
L.S.D 5%	**0.046**	----	**0.045**	----	**0.043**	----	**0.041**	----

N= 4000 eggs of *M. incognita*
**** Each value is the mean of nine replicates.**
Means in each column followed by the same letter (s) did not differ at P<0.05 according to Duncan multiple- rage test

Table (4): Effect of three components at two levels each on tomato plant cv. 888 fruit number, yield and its diameter under the stress of *Meloidogyne incognita* infection or not in the wire house conditions during the seasons of 2011 and 2012.

Characters / Treatments	**Chemical components of tomato leaves											
	1st Season						2nd Season					
	No. fruit	Inc. %	D.M fruit	Inc. %	T. yield/pl	Inc.%	No. fruit	Inc. %	D.M fruit	Inc. %	T. yield/ pl(g)	Inc. %
INFECTED												
Protecto 0.9 +N	14.35 k	51.1	3.93 j	40.4	654.22 l	84.2	14.55 k	69.8	3.65 j	48.9	660.35 l	80.8
Protecto 1.8+N	12.43 m	30.8	3.40 l	21.4	566.38 n	59.5	12.87 m	14.4	3.55 l	44.8	575.45 n	57.6
FYM 42+N	13.73 l	44.5	3.76 k	34.3	625.86 m	76.3	14.25 l	26.7	4.12 k	68.2	633.66 m	73.5
FYM 63+N	15.94 h	67.8	4.36 g	55.7	726.51 i	104.6	15.88 h	41.2	4.66 g	90.2	740.11 i	102.6
Ammonia 30+N	16.48 e	73.5	4.51 e	61.1	751.21 e	111.6	17.66 e	56.9	4.80 e	95.9	765.33 e	109.6
Ammonia 60+N	17.46 c	83.8	4.78 c	70.7	796.05 c	124.2	18.32 c	62.8	5.35 c	118.4	802.11 c	119.7
Oxamyl+ N	16.78 d	76.6	4.59 d	63.9	764.94 d	115.4	17.21 d	52.9	5.24 d	113.9	789.87 d	116.3
N alone	9.50 n	----	2.80 m	-----	355.08 o	----	11.25 n	----	2.45 m	----	365.12 o	----
UNINFECTED												
Protecto 0.9	16.40 f	56.19	4.49 ef	44.83	747.55 f	84.24	16.55 f	74.21	4.65 ef	50.00	752.65 f	85.31
Protecto 1.8	15.74 i	49.90	4.31 h	39.03	717.36 j	76.80	15.89 i	67.26	4.58 h	47.74	721.55 j	77.65
FYM 42	16.26 g	54.85	4.45 f	43.55	741.15 g	82.66	17.15 g	80.52	5.25 f	69.35	750.21 g	84.71
FYM 63	17.83 j	69.8	4.92 i	58.7	901.72 k	122.2	16.65 j	75.26	5.99 i	93.2	710.88 k	75.03
Ammonia 30	18.83 b	79.30	5.5 b	77.4	912.52 b	124.9	18.42 b	93.89	6.11 b	97.1	819.87 b	126.5
Ammonia 60	19.99 a	90.4	5.9 a	90.3	928.99 a	128.9	18.74 a	97.26	6.25 a	101.6	845.45 a	132.8
Plant free	10.5 o	----	3.10 n	----	405.74 h	----	9.5 o	----	3.1 n	-----	406.15 h	-----
L.S.D at 0.05%	0.046	---	0.045	---	0.246	---	0.043	---	0.042	-----	0.234	-----

N= 4000 eggs of *M. incognita **** Each value is the mean of nine replicates.**
****Means in each column followed by the same letter (s) did not differ at < 0.05 according to Duncan multiple- rage test.**

Table (5) Nematode parameters of *Meloidogyne incognita* infecting tomato plants cv. 888 as influenced by Ammonia, FYM and Protecto separately at two levels each in comparison with oxamyl in the wire house conditions in the 1st season 2011.

Treatments	*Nematode parameters									
	J_2 in soil	In root						Final population	RF****	% Red.
		No. of galls	RGI***	No. of D. Stages	Female	E. masses	EI***			
Protecto 0.9	1103.0 a	33.0 b	4	50 e	28.0 b	20.0 b	3	1181 b	0.295	83.5
Protecto 1.8	1004.0 b	27.0 d	3	60 b	19.0 d	17.0 c	3	1083 c	0.271	84.9
FYM 42	409.0 d	31.0 c	4	50 e	25.0 c	21.0 b	3	484 d	0.121	93.2
FYM 63	209.0 e	25.0	3	52 c	19.0 d	18.0 c	3	280 e	0.070	96.1
Ammonia 30	199.0 f	22.0 e	3	51 d	17.0 e	15.0 d	3	267 f	0.067	96.3
Ammonia 60	185.0 g	18.0 f	3	30 g	12.0 f	9.0 e	3	227 g	0.057	96.8
Oxamyl	177.0 h	18.0 f	3	25 f	9.0 g	7.0 f	3	211 h	0.053	97.0
N alone	500.8 c	600.0 a	5	1582 a	560.0 a	510.0 a	5	7150 a	1.788	-----
LSD 0.05	0.165	0.166	----	0.173	0.172	0.174	----	0.173	-----	-----

J_2 = Juveniles of *M. Incognita*

*N= 4000 eggs of *M. incognita*.

** Each value is the mean of nine replicates..

**** Reproduction factor = $\frac{\text{final population}}{\text{Initial population}}$ = RF

*** Root gall index (RGI) or egg-masses index (EI) was determined according to the scale given by Taylor and Sasser (1978) as follows : 0= no galls or eggmasses, 1= 1-2 galls or eggmasses , 2= 3-10 galls or eggmasses, 3= 11-30 galls or eggmasses, 4= 31-100 galls or eggmasses and 5= more than 100 galls or eggmasses.

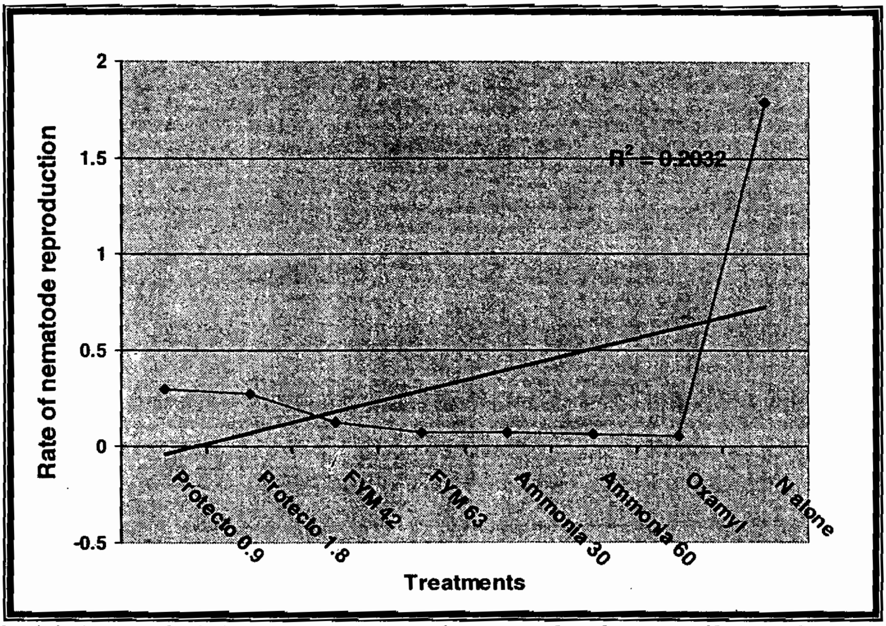

Fig (1): Rate of *Meloidogyne incognita* reproduction as affected by three components at two levels on tomato cv. 888 plant under wire house conditions during the season of 2011.

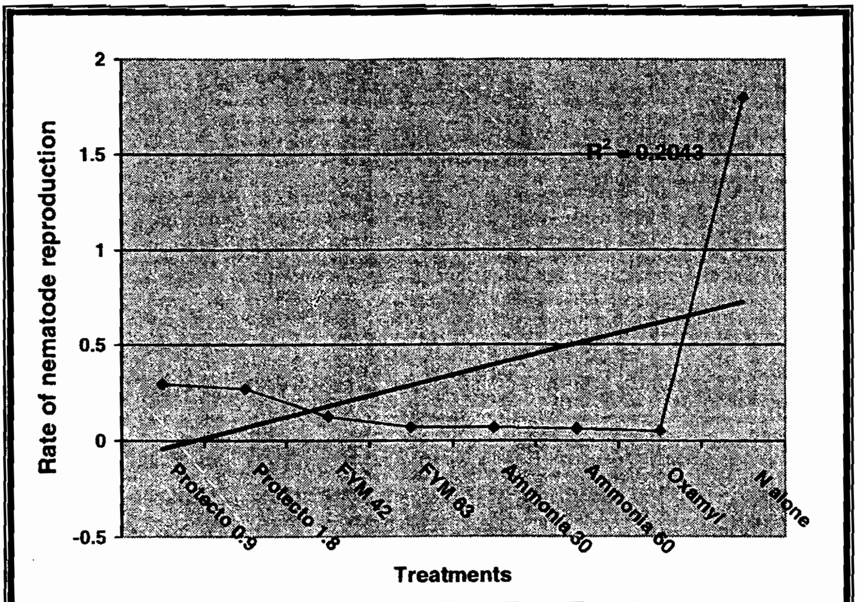

Fig (2): Rate of *Meloidogyne incognita* reproduction as affected by three components at two levels on tomato cv. 888 plant under wire house conditions during the season of 2012.

Table (6) Nematode parameters of *Meloidogyne incognita* infecting tomato plants cv. 888 as influenced by Ammonia, FYM and Protecto separately at two levels each in comparison with oxamyl under wire house conditions in the 2nd season 2012.

Treatments	*Nematode parameters									
	J_2 in soil	In root						Final population (Pf)	RF****	% Red.
		No. of galls	RGI***	No. of D. Stages	No. of Female	No. of E. masses	EI***			
Protecto 0.9	1109.0 b	36.0 b	4	40 d	30.0	28.0 b	3	1179 b	0.295	83.6
Protecto 1.8	1011.0 c	29.0 c	3	50 b	20.0	18.0 d	3	1081 c	0.270	84.9
FYM 42	412.0 d	28.0 c	3	48 c	28.0	24.0 c	3	488 d	0.122	93.2
FYM 63	219.0 f	22.0 d	3	34 e	19.0	17.0 d	3	273 e	0.068	96.2
Ammonia 30	222.0 e	16.0 e	3	32 f	18.0	15.0 e	3	272 f	0.068	96.2
Ammonia 60	199.0 g	10.0 f	3	31 f	11.0	10.0 f	2	242 g	0.061	96.6
Oxamyl	165.0 h	10.0 f	3	28 g	9.0	6.0 g	2	202 h	0.051	97.2
N alone	5022 a	604.0 a	5	1596 a	576	524 a	5	7194 a	1.799	-----
LSD 0.05	0.15	0.16	----	0.17	----	0.16	----	0.16	----	----

*N= 4000 eggs of *M. incognita*.

** Each value is the mean of nine replicates..

**** Reproduction factor = $\frac{\text{final population}}{\text{Initial population}}$ = RF

*** Root gall index (RGI) or egg-masses index (EI) was determined according to the scale given by Taylor and Sasser (1978) as follows : 0= no galls or eggmasses, 1= 1-2 galls or eggmasses , 2= 3-10 galls or eggmasses, 3= 11-30 galls or eggmasses, 4= 31-100 galls or eggmasses and 5= more than 100 galls or eggmasses.

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مكافحة نيماتودا تعقد الجذور"ميليدوجيني إنكوجنيتا" علي نباتات الطماطم باستخدام الرش الورقي لمحلول الأمونيا أو إضافة السماد العضوي *Bacillus theringiensis* كمحسنات تربة منفصلة مقارنة بمبيد الأوكساميل تحت ظروف الصوبة السلكية.

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تم دراسة تقييم إضافة السماد العضوي القديم لحيوانات المزرعه والمركب الحيوي (Bt) *Bacillus theringiensis* كمحسنات تربة للنباتات ورش الأمونيا بمعدل مستويان لكل منها منفردا وذلك بمعدل ٤٢ و ٦٣ جرام لكل نبات للأول و ٠.٩ و ١.٨ جرام / نبات للثاني و ٣٠ و ٦٠ مللتر/ نبات للثالث مقارنة بمبيد الأوكساميل بمعدل ٠.٩ جم/ نبات الجرعه الموصي بها علي نمو نباتات الطماطم صنف ٨٨٨ المصابة بنيماتودا تعقد الجذور "ميليدوجيني انكوجنيتا" والمعداه بمعدل ٤٠٠٠ بيضة لكل نبات في أصيص به ٣ كجم تربة معقمة مكونه من ٢٧.٩٦ جزء رمل و ٣٢.٤ جزء سلت و ٣٩.٦ جزء طمي ويطلق عليها طينية طميية وحصدت التجربة في كل موسم علي حده للعامين ٢٠١١، ٢٠١٢ بعد مرور ٦٠ يوم من إضافة عدوي النيماتودا وأخذت القياسات النباتية للطماطم المعداه وغير المعداه لكل معاملة منفصلة وقدرت القياسات النيماتودية في النباتات المعداه لكل معاملة منفصله بالطرق العلمية السليمة وأسفرت النتائج علي ما يلي:-

أن القياسات النباتية للطماطم المصابة وغير المصابة لموسمي النمو ٢٠١١، ٢٠١٢ فكانت كما يلي:

١- كلما زاد مستوي السماد العضوي من ٤٢ إلي ٦٣ جم/ نبات كمحسن عضوي للتربة ومن ٣٠ الي ٦٠ مللتر /نبات للأمونيا رشا علي النبات منفصله كلما زاد معدل طول النبات والوزن الرطب الكلي للنبات والوزن الجاف للمجموع الخضري والوزن الجاف للأوراق والمحصول الكلي لثمار الطماطم وقطرها وعددها في النباتات المصابة والغير مصابة لموسمي النمو. بينما المستوي الأقل من المركب الحيوي (Protecto (B.t. بمعدل ٠.٩ جم/ نبات أعطي نتائج أفضل من المستوي الأعلي ١.٨ جم/ نبات للمركب الحيوي في هذا السياق.

٢- تفوق معاملة الأمونيا بالمستوي الأعلي ٦٠ مللتر/ نبات رشا علي نباتات الطماطم المصابة وغير المصابة بالنيماتودا علي باقي المعاملات المختبرة في معدل الزيادة لطول النبات والوزن الرطب الكلي للنبات الوزن الجاف للمجموع الخضري والوزن الجاف للأوراق ومحصول ثمار الطماطم الكلي وقطر الثمرة وعددها بقيم ٨٩.٩٢ & ٧٠.٢%، ٦٨.٩& ٥٩.٥٣%، ٨٩.٧& ٧٥.٣%، ٧٥.٣٤& ٦٥.٩%، ٥٩.٤& ٦١.١%، ٧١.١& ٥١.٢%، ١٢٨.٩&١٣٢.٨%، ٩٠.٣& ١٠١.٦%، ٩٠.٤& ٩٧.٢٦% مقارنة بالغير مصاب وغير معامل في موسمي النمو ٢٠١١& ٢٠١٢ علي التوالي.

٣- تم تسجيل نتائج مشابهه لنفس المعاملة بالنسبة للنباتات المعاملة والمصابة بالنيماتودا في موسمي النمو ٢٠١١، ٢٠١٢ بقيم قدرها ٧٠.٦٨& ٦٥.٤٤% ، ٨٤.٠& ٧٥.٢٥%، و ١٢٤.٢& ١١٩.٧% و ٧٠.٧& ١١٨.٤% و ٨٣.٨& ٦٢.٨% لنفس الصفات النباتية السابقه مقارنة بالنيماتودا وحدها لموسمي النمو ٢٠١١& ٢٠١٢. كما أعطت المعاملة بالمركب الحيوي Protecto عند مستوي ١.٨ جم/نبات أقل قيم لطول النبات (٢١.٤٤& ٢٧.٧٨%) والوزن الرطب الكلي للنبات (١٧.٧& ١٥.١٣%) والوزن الجاف للمجموع الخضري (١٢.٤١& ١٣.٩٨%) والوزن الجاف للأوراق (١٢.٨٢& ١٣.٧٥%) ومحصول الطماطم (٥٩.٥& ٥٧.٦%) وقطر الثمرة (٢١.٤& ٤٤.٨%) وعدد الثمار (٣٠.٨& ١٤.٤%) علي التوالي لموسمي الدراسة للنباتات المصابة بالمقارنة بالنيماتودا.

٤- تم تسجيل نتائج مشابهة لنفس المقاييس النباتية بالمعاملة (B.t) بمعدل ١.٨ جم/ نبات في النباتات الغير مصابة لموسمي النمو تحت الدراسة مقارنة بالنباتات غير معاملة غير مصابة علي التوالي.

أما بالنسبة لتأثير المعاملات الستة المختبرة لمكافحة نيماتودا تعقد الجذور *M. incognita* علي نباتات الطماطم صنف ٨٨٨ مقارنة بمبيد الأوكساميل عند الجرعه الموصي بها تحت ظروف الصوبة السلكية خلال موسمي ربيع ٢٠١١& ٢٠١٢ أسفرت النتائج عن ما يلي:-

١- أوضحت الدراسة ان المعاملات المختبرة أدت إلي خفض أعداد العقد النيماتودية واليرقات في التربة والأطوار غير الكاملة وكتل البيض وتعداد النيماتودا ومعدل تكاثرها بدرجة معنوية مقارنة بالنيماتودا وحدها.
٢- كانت مستويات الأمونيا ٣٠، ٦٠ مللتر/نبات رشاً منفرده أنهما أفضل المعاملات المختبرة في خفض مقاييس النيماتودا تحت الدراسة خلال موسمي ٢٠١١، ٢٠١٢ يليهافي ذلك معاملة مخلف السماد العضوي ٦٣ جم/ نبات علي التوالي مقارنة بالنيماتودا وحدها.
٣- تفوق معاملة مبيد الأوكساميل علي كل المعاملات المختبرة في خفض مقاييس النيماتودا في تربة جذور الطماطم بقيم ٩٧.٠ و ٩٧.٢% للتعداد النهائي للنيماتودا خلال ربيع موسمي ٢٠١١& ٢٠١٢ علي التوالي مقارنة بالنيماتودا وحدها.

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