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STUDY THE EFFECT OF MAGNETITE ORE AND OTHER NATURAL MATERIALS ON CONTROL OF CITRUS NEMATODE (*Tylenchulus semipenetrans* Cobb) AND ITS IMPACT ON PRODUCTIVITY OF BALADY MANDARIN.

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ABSTRACT

In Egypt and several other parts of the world there are many nematode pests parasitize on citrus, one of which is the citrus nematode (*Tylenchulus semipenetrans* Cobb) that causes slow decline disease and causing yield losses ranging from 8.7 to 14.2%. Twenty years old trees of Balady mandarin (*Citrus reticulata Blanco*) budded on sour orange rootstock (*Citrus aurantium*, L.Osbeck) and growing in loam soil in a private orchard infected with nematode, located at El Mansorya County, El Giza Governorate, Egypt were selected for two seasons (2015 and 2016) and treated by different natural materials i.e. Magnetite (Magnetic iron ore), Tourmaline ore, Biocide ore as a source of silicon and Nemastop as a source of garlic extract to control citrus nematode. The treatments and its concentrations were Magnetite ore at (500, 750 gm/ tree), Tourmaline ore + Biocide ore at (20,40gm/ tree for each), Nemastop at (25, 50 cm^3/ tree) and control treatment. Data showed that, the best treatment respectively; was 500gm of Magnetite ore / tree for achieving maximum average nematode reduction % in roots (- 85, - 84%) over zero days (initial population) during the two seasons (2015 and 2016), and for achieving maximum averages of total root phenols content (%) which play a major role in pathophysiological reactions in tissues inducing a defense mechanism and resistance to aggressive pathogens. Also, the same treatment resulted in maximum yield and high fruit quality (Juice weight %, T.S.S/ Acid and Vitamin C). Based on the economic study, it could be recommended to use 500 gm of Magnetite ore for achieving the best total yield and producing the highest net profit / fed. (3390 L.E) followed by either use 20gm. of Tourmaline ore/ tree plus 20gm. of Biocide ore/ tree (2115 L.E) or use 50 cm^3 Nemastop / tree (1425 L.E). Also, it must be preferred the available material and least price in the market.

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Keywords: Magnetite, Tourmaline, Biocide, Nemastop, Citrus nematode, Yield, Fruit quality and Mandarin trees.

INTRODUCTION

The citrus nematode was first discovered infecting citrus in California (Thomas 1913). After that year, Nathan Cobb (1913) described this nematode as a new species, *Tylenchulus semipenetrans* (Cobb), which then was identified as the causal agent of slow decline in citrus. Since its discovery, *T. semipenetrans* has been found in every citrus growing region of the world (Duncan, 2005). Egypt is one of major citrus producing countries in the world. Unfortunately, in Egypt and several other parts of the world there are many nematode pests parasitize citrus, one of which is the citrus nematode (*Tylenchulus semipenetrans* Cobb) that causes of the slow decline disease (Oteifa and Tarjan, 1965) and causing yield losses ranging from 8.7 to 12.2% according to Cohn (1972) or from 8.7 to 14.2% according to Sasser (1989).Also, in Egypt, Abd-Elgawad (1995) found significant negative correlation between navel orange yield and population density of the citrus nematode. Therefore, efforts are being made to increase yield through effective management of the citrus nematode. Controlling of nematode diseases on citrus depends mainly on chemical applications while, these chemical substances are always undesirable due to their high cost and their hazard potentials to the environment. For this reasons, the applied strategy today is directed towards replacing the use of hazardous chemical nematicides by environmentally friendly natural materials**.**

Natural materials i.e., Magnetite (Magnetic iron ore), Tourmaline ore, Biocide ore (as a source of silicon) and Nemastop (as a source of garlic extract) were used as alternative materials to control citrus nematodes. Magnetic iron ore have very accurate with high magnetic if contact with water, the resulting will be electromagnetic field which helps the passage of useful elements to plant and eliminate nematodes and microbes from rhizoshere of plant roots (El- Sherif, *et al*., 2014). Application of magnetic iron ore significantly reduced root-knot nematode populations either in the soil or in roots on two grapevine cultivars Superior and Thompson Seedless (Ismail, *et al.,* 2010) .Also, magnetic iron increased plant growth and leaf mineral content on Valencia orange trees (Hoda, *et al*., 2013),on cauliflower (Mansour, 2007) and on roselle plants (*Hibiscus sabdariffa L.*) Yasser, *et al.*, (2011). Moreover, Matsudo, *et al.,* (1993) reported that, magnetic field had a positive effect on the number of strawberry flowers and total yield. Tourmaline is one kind of widespread minerals in nature, which is famous for its electric properties (Guo and Qian, 1997). Tourmaline crystals are piezoelectric and often pyroelectric as well. It has the spontaneous and permanent poles, which could produce an electric dipole (Jin *et al*., 2003 and Nakamura *et al.,* 1994). The electric field may have negative or positive effect on the growth and metabolism of organism (Cao, *et al.,* 2003). Biocide ore as a source of silicon (Si) shows

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promising as an environmentally friendly choice. The Si has the potential to decrease the intensity of important diseases in several economic crops, especially cereals and some dicots (Datnoff *et al.,* 2007). Silva, *et al.,* (2010) investigated the effect of Si on coffee resistance to root- knot nematode (*Meloidogyne exigua*) at the biochemical level and found that the high Si concentration in the roots of plants supplied with Si contributed to reduce the number of galls and the number of eggs due to an increase in the concentration of lignin-thioglycolic acid derivatives and the activities of peroxidases, polyphenoloxidases and phenylalanine-ammonia lyases. Nemastop as a source of garlic (*Allium sativum* L.) is one of those plants that were seriously investigated over several years and used for centuries to fight infectious diseases (Onyeagba, *et al.,* 2004). Garlic contains at least 33 sulfur compounds, one of the most biologically active compounds in garlic is Allicin (diallyl thiosulfinate or diallyl disulfide), several enzymes and the minerals germanium, calcium, copper, iron, potassium, magnesium, selenium and zinc; vitamins A, B1 and C, fiber and water. It also contains 17 amino acids to be found in garlic: lysine, arginine, histidine, aspartic acid, swine, threonine, glutamine, proline, glycine, alanine, valine, cysteine, methionine, isoleucine, leucine, tryptophan and phenylalanine (Josling, 2005).

The aim of this investigation is to study the effect of some natural materials application i.e. Magnetite (Magnetic iron ore), Tourmaline ore, Biocide ore and Nemastop on control citrus nematode and its impact on fruit quality and yield of mandarin trees.

MATERIALS AND METHODS

Twenty years old trees of Balady mandarin (*Citrus reticulata Blanco*) budded on sour orange rootstock (*Citrus aurantium*, L.Osbeck) planted at 5x5m a apart and growing in loam soil in a private orchard, belong to Mr. Hammad located at El Mansorya County, El Giza Governorate, Egypt were selected for two seasons (2015 and 2016). The experiment area was irrigated by flood irrigation system. Twenty one of Balady mandarin trees at "on year" were used according to vigor and number of flowers for data collection. Four materials were used in the experiment as follow: **1)** Magnetite (Magnetic iron ore), contained 48.8% Fe_3O_4, 17.3% Fe O, 26.7% Fe_2O_3, 2.6% MgO, 4.3% SiO_2 and 0.3% CaO. **2)** Tourmaline ore, contained 349.38 ppm Ca^{+2}, 50.07 ppm Mg^{+2}, 543.50 ppm K^{+}, 9.00 ppm Fe, 0.15 ppm Mn and 34.30 ppm Cu. **3)** Biocide ore contained 16.4% CaO, 0.35% TiO_2, 8.67% Al_2O_3, 1.13% Fe_2O_3, 0.10% MnO, 1.64% MgO, 0.87% Na_2O, 0.65% K_2O, 0.26% P_2O_5, 1.65% SO_3, 0.55% Cl and 46.56% SiO_2 which represent the major component in this raw material. All these materials were obtained from a private company.**4)** Nemastop is a suspension containing 600 g ground garlic cloves/liter of water produced by the Organic Agriculture Lab., Agric. Res. Center, Giza, Egypt.

A complete randomized block design with three replicates for each treatment was done.

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The experiment involved seven treatments including control as follow:

1- Control (untreated trees)
2- 500gm of Magnetite ore / tree.
3- 750gm of Magnetite ore / tree.
4- 20gm of Tourmaline ore / tree + 20gm of Biocide ore / tree.
5- 40gm of Tourmaline ore / tree + 40gm of Biocide ore / tree.
6- 25cm^3 of Nemastop / tree.
7- 50cm^3 of Nemastop / tree.

In mid- March of each season (2015 and 2016) all treatments were added to the soil at two trenches (100cm length x 20 cm width x 20cm depth) in both sides of the tree which was done at the end of the tree shadow , then immediately followed by irrigation. The following parameters of the studied treatments were carried out**:-**

Nematode populations. Soil and root samples for nematode extraction were taken at 30 cm depth beneath the tree canopy once before the addition of the treatments as the initial population. After soil incorporation with the treatments, soil and root samples were collected 30, 60 and 90 days after application. Nematodes in an aliquot of 200 g soil were extracted by the sieving and decanting technique (Barker, 1985). Roots were gently cleaned from adhering soil particles and an aliquot of 5 g from each sample was incubated in Baermann dishes under laboratory conditions 25±2 ºC for 7 days and the nematode populations were counted (Southey, 1970). Percentage nematode reduction either in soil or roots was recorded.

Total phenols. Total phenol in roots was determined using the Folin- Ciocalteau reagent according to Malick and Singh (1980).

Yield. The number of fruits per tree was counted at the harvesting time (mid February) in each season (2015 and 2016). The yield per tree (kg) was determined and the theoretical yield (ton/ fed.) was calculated.

Fruit quality. Ten fruits were randomly taken in the both seasons for each replicate and the following determinations were carried out:
Average of fruit weight (gm.), Juice weight percentage, total soluble solids (T.S.S %) and total acidity (%) were determined in fruit juice according to (A.O.A.C, 1995). Total soluble solids / acid ratio was calculated from the values of total soluble solids divided by values of total acids. Ascorbic acid (Vitamin C) was calculated as mg/100 ml juice according to (Horwitz, 1972).

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Statistical analysis: The experiment was designed in a completely randomized block design with three replicates for each treatment and each replicate was represented by one tree. The obtained data for two seasons were analysis of variance according to Clark and Kempson, (1997) and the means were differentiated using Duncan multiple range test at 5% level (Duncan, 1955).

RESULTS AND DISCUSSIONS

Populations of citrus nematode (*Tylenchulus semipenetrans* Cobb). Population and reproduction ability of a particular nematode is calculated by using its initial and final population during a crop growth periods. Data in (Table 1) showed the effect of Magnetite and other natural materials application on the nematode (*Tylenchulus semipenetrans* Cobb) populations in soil at 30, 60 and 90 days after application during the two seasons (2015 and 2016). The results indicated that the average of the nematode in soil over 0 days (initial population) for control trees increased with increasing the periods of time whereas the average population of 30, 60 and 90 days after application of treatments reached to (143% and 31%) during the two seasons, respectively as compared with nematode populations at 0 days (initial population). While, all the tested treatments attained different reduction values in nematode populations at the rhizosphere area and the reduction (%) increased with increasing the periods of time and the maximum reduction (%) was in 90 days after application. Also, 500gm Magnetite was superior in the first season (2015) whereas the maximum average reduction (%) reached to (- 65%) over 0 days (initial population) while trees treated by 750gm Magnetite recorded (- 69%) in the second season (2016). Moreover, trees received 40gm Tourmaline +40gm Biocide had (-52, 63%) during the two seasons, respectively. On the other hand, 25cm3 Nemastop treatment scored the minimum average reduction % (- 21, 35%) in the first and second season, respectively.

As for nematode populations in roots, results in (Table 2) indicated that, all the doses of the materials had significantly reduced *T. semipenetrans* populations in the roots throughout the experimental period. Also, significant differences were observed between and within the treatments. In more details, trees treated by 500gm Magnetite was superior for achieving maximum average nematode reduction % (- 85, - 84%) over 0 days(initial population) through 30, 60 and 90 days, also, 750gm Magnetite treatment scored (- 81, - 82%) with no significant between Magnetite treatments during the two seasons 2015 and 2016, respectively, followed by 20gm Tourmaline +20gm Biocide treatment which gave (- 78, - 72%) and 50cm3 Nemastop treatment (-70, - 39%) in the first and second season, respectively. On the other side, the average populations of the nematode in roots of untreated trees increased over 0 days with increasing the periods of time (+ 55, + 82%) during the two seasons (2015 and 2016), respectively.

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Magnetite, a ferrimagnetic iron oxide (Fe_3O_4), is produced biogenically in organisms ranging from bacteria to humans (Kirschvink, *et al.*, 1992). Magnetite have very accurate with high magnetic if contact with water the resulting will be electromagnetic field (El- Sherif *et al*., 2014). The electromagnetic field produces of heat-shock proteins in nematode *Caenorhabditis elegans* (Charles, *et al*., 2014) and therefore this led to decrease the populations of the citrus nematode (*Tylenchulus semipenetrans* Cobb) in the roots . Application of magnetic iron significantly reduced root-knot nematode populations either in the soil or in roots on two grapevine cultivars Superior and Thompson seedless (Ismail, *et al.,* 2010). Also, the results were in harmony with the finding of El-Sherif, *et al*., (2014) who mentioned that the application of moringa powder and Magnetic iron on Eggplant accomplished the highest percentage reduction of final nematode population. Also, our results may shed light on the application of Tourmaline and (Biocide as a source of silicon). Tourmaline has electric properties (Guo and Qian, 1997). This electric field may have negative or positive effect on the growth and metabolism of pathogens (Cao, *et al.,* 2003). Moreover, silicon accumulates in the cell wall of plants and form silicon-cellulose network.

which acts as a mechanical barrier against pathogen (Takahashi and Miyake, 1977).Silicon accumulation reduces nematode infection and attack of mites in crop plants (Tanaka and Park, 1966). The roots of rice plants containing high silicon were found to resist the infection of root-knot nematodes (Swain and Prasad, 1988). The reduction in nematode infection due to high silicon content was also observed in coffee and cucumber plants (Silva, *et al*., 2010). On the other hand, Nemastop as a source of garlic reduced citrus nematode population in the present work and this may be attributed to one of the most biologically active compounds in garlic is Allicin which exhibits anti-parasitic activity against major human intestinal parasites such as *Entamoeba histolytica, Ascaris lumbricoides* and *Giardia lamblia* (Kalyesa, 1975). Also, high tannin content in garlic *(Allium. Sativum*) may have direct anti helmentic effects on resident worm populations, disrupting the normal physiological function like mobility, food absorption, and reproduction (Masamha, *et al*., 2010).Also, Duval, (2004) asserted that garlic *(Allium. Sativum*) prevents the production of eggs of certain parasites from developing into larva. This reduction in larva on herbage will subsequently reduce the buildup of nematode in hosts. In addition, Osman, *et al.,* (2005) found a positive correlation between application of a high dose of crushed garlic and percentage reduction of *Meloidogyne incognita* on cowpea.

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Table 1. Effect of Magnetite ore and other natural materials application on soil citrus nematode (*Tylenchulus semipenetrans* Cobb) populations during two seasons (2015 and 2016).

Treatments	1st season					2nd season				
	Nematode populations in 200 g soil after application									
	0 days	Nematode reduction (%) Increase(+) or decrease(-) over 0 days			Mean nematode reduction + or – (%)over 0 days	0 days	Nematode reduction (%) Increase(+) or decrease(-) over 0 days			Mean nematode reduction + or – (%)over 0 days
		30 days	60 days	90 days			30 days	60 days	90 days	
Control	300	684 (+128)	724 (+141)	783 (+161)	**+143 a**	916	1050 (+16)	1060 (+16)	1479 (+61)	**+ 31 e**
500gm Magnetite	565	101 (-82)	329 (-42)	170 (-70)	**- 65 b**	889	688 (-23)	511 (-42)	456 (-49)	**- 38 d**
750gm Magnetite	232	324 (-40)	321 (-52)	208 (-18)	**- 38 c**	1252	580 (-54)	328 (-74)	264 (-79)	**- 69 a**
20gm Tourmaline +20gm Biocide	338	170 (-50)	104 (-69)	233 (-31)	**-51 bc**	1310	538 (-59)	495 (-62)	488 (-63)	**- 61 b**
40gm Tourmaline +40gm Biocide	408	167 (-59)	140 (-65)	330 (-31)	**-52 b**	905	410 (-55)	379 (-59)	214 (-76)	**- 63 b**
25cm^3 Nemastop	164	120 (-27)	175 (-12)	123 (-25)	**-21 d**	584	367 (-37)	364 (-38)	414 (-29)	**- 35de**
50cm^3 Nemastop	225	113 (-50)	146 (-35)	154 (-32)	**- 39 c**	447	384 (-27)	210 (-53)	195 (-56)	**- 45 c**

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different. Figures in parenthesis indicate mean nematode reductions over zero days of 30, 60 and 90 days**.**

Total phenol (%). Phenol compounds have been recognized to play a major role in pathophysiological reactions in tissues inducing a defense mechanism and resistance to aggressive pathogens Hung and Rohde (1973) and Rezk (1976) recorded that total phenol accumulation was high in fungus and nematode resistant plants. The averages of total root phenols content (%) fractions at the various treatments during the two seasons (2015 and 2016) are given in Figure 1. Any treatment which helps activation, builds up or stimulates the accumulation of phenolic compounds in tissues may suppress or inhibit expansion of parasitism.

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The results indicated that, mandarin trees treated by 500gm/tree Magnetite had maximum average (0.88%) followed by

Table 2. Effect of Magnetite ore and other natural materials application on root citrus nematode (*Tylenchulus semipenetrans* Cobb) populations during two seasons (2015 and 2016).

	1st season					2nd season				
	Nematode populations in 5 g roots after application									
		Nematode reduction (%) Increase (+) or decrease(-) over 0 days			Mean nematode reduction + or – (%)over 0 days		Nematode reduction (%) Increase (+) or decrease(-) over 0 days			Mean nematode reduction + or – (%)over 0 days
Treatments	0 days	30 days	60 days	90 days		0 days	30 days	60 days	90 days	
Control	177	186 **(+29)**	229 **(+29)**	354 **(+108)**	**+ 55 a**	370	450 **(+32)**	531 **(+44)**	1000 **(+170)**	**+ 82a**
500gm Magnetite	224	64 **(-86)**	42 **(-83)**	94 **(-87)**	**- 85 a**	693	134 **(-81)**	129 **(-81)**	75 **(-89)**	**- 84a**
750gm Magnetite	476	154 **(-67)**	30 **(-93)**	78 **(-83)**	**- 81ab**	1164	397 **(-66)**	135 **(-89)**	104 **(-91)**	**- 82a**
20gm Tourmaline +20gm Biocide	390	142 **(-64)**	58 **(-85)**	56 **(-86)**	**- 78ab**	299	286 **(-65)**	190 **(-75)**	162 **(-75)**	**- 72b**
40gm Tourmaline +40gm Biocide	201	84 **(-58)**	57 **(-71)**	82 **(-59)**	**- 63de**	246	184 **(-29)**	173 **(-30)**	142 **(-42)**	**- 34c**
25cm^3 Nemastop	212	91 **(-57)**	38 **(-82)**	83 **(-61)**	**- 67cd**	228	163 **(-29)**	158 **(-31)**	111 **(-51)**	**- 37c**
50cm^3 Nemastop	305	43 **(-71)**	51 **(-82)**	40 **(-58)**	**- 70bc**	322	112 **(-33)**	81 **(-36)**	80 **(-46)**	**- 39c**

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different. Figures in parenthesis indicate mean nematode reductions over zero days of 30, 60 and 90 days**.**

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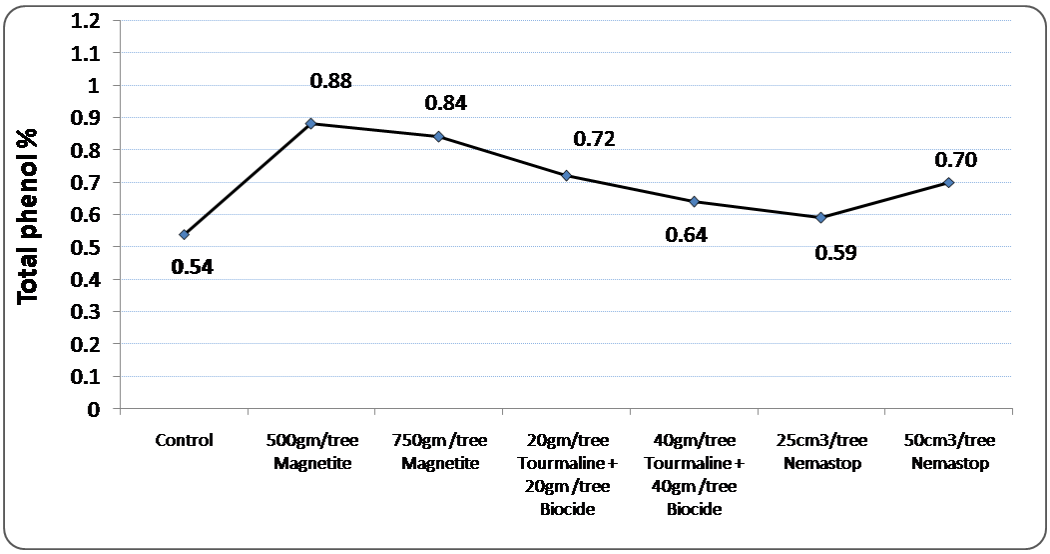

Fig 1. Effect of Magnetite ore and other natural materials application on average total root Citrus phenols (%) content during the two seasons (2015 and 2016).

trees treated by750gm/tree Magnetite(0.84%) and20gm tourmaline + 20gm Biocide/tree (0.72%) while the minimum average (0. 54%) was obtained by untreated trees (control treatment). On the other hand, 25cm/tree Nemastop treatment was associated with synthesis of phenolics in treated plants which was closely correlated with a marked decline in nematode populations (0.59%). This concept is supported by previous work on the significance of phenols for resistance in plants to nematodes and fungi. Hung and Rohde (1973), Paxton (1975) confirmed the same conclusion that extensive composition of phenols has been an important feature of plants resistant to fungi and nematodes. Moreover, the concentrations of phenolic and lignin secondary compounds in citrus roots also vary seasonally and have been shown to be inversely related to *T. semipenetrans* population growth (Duncan *et al.*, 1993). In addition, higher levels of phenols in nematode-infected citrus plant roots were associated with higher reduction in numbers of *T.semipenetrans* larvae and females and vice-versa. The amount of phenolics increased in infected plants, possibly due to breakdown of glucosides as a result of secreted glucosidase by the parasitizing microorganism, which eventually enriched infected tissues with phenolics. (Badra and El- Gindi, 1979).

Yield. Data tabulated in (Table 3) show the number of fruits/tree, fruit weight (gm), yield Kg/tree and yield (ton) / feddan , also(Figure 4) show the average change rate of mandarin productivity (%) during two seasons (2015 and 2016). Reduction the population of root citrus nematode (*Tylenchulus semipenetrans* Cobb) as a result of different treatments application reflected an increase in average mandarin productivity, and the results indicated that the

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application of 500gm/ tree Magnetite was recommended to achieve maximum average productivity over control (23.76%) followed in descending order by750gm/ tree Magnetite(19.56%) and 20gm Tourmaline + 20gm Biocide/ tree (14.83%)then 50cm Nemastop (9.99%) as compared with control treatment. These results are in the same line with the obtained resulted by (Hoda, *et al*., 2013) on Valencia orange trees growing in soil influenced by salinity and they indicated that, the application of 750 gm. Magnetite plus biofertilizer was the best combination for achieving the highest total yield. Also, Taha *et al*., (2011) working on *Capsicum Annuum* L. under saline irrigation conditions revealed that, the highest significant increase in yield appeared under the highest dose of Magnetite treatments (4g/pot) .Moreover, Mansour,(2007) showed that, there were gradual increments in curd characters and yield of cauliflower plants by increasing the Magnetite levels, this increase might be attributed to the stimulating effect of Magnetite on plant growth and the more absorption of N, P, K, and Ca. Our results were in harmony with finding by (Arab *et al*., 2011) who found that, in Iran the application of 600 kg Silicon ha^{-1} and 4 liter cycocel ha^{-1}increased total yield of rice.

Table 3. Effect of Magnetite ore and other natural materials application on yield of mandarin trees during two seasons (2015 and 2016).

	Fruit No.		Fruit Weight (gm)		Yield (kg. / tree)		Yield (Ton / fed.)	
Treatments	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	490ab	490ab	119 b	123 b	58.45 f	60.42 e	9.35 f	9.67 e
500gm Magnetite	522 a	507 a	140 a	147 a	72.89 a	74.20 a	11.66a	11.87a
750gm Magnetite	503ab	493ab	140 a	147 a	70.12ab	71.97ab	11.22ab	11.51ab
20gm Tourmaline +20gm Biocide	493ab	477ab	137ab	145 a	67.40bc	69.03bc	10.78bc	11.05bc
40gm Tourmaline + 40gm Biocide	473ab	457ab	132ab	140ab	62.12de	63.83de	9.94 de	10.21de
25cm^3 Nemastop	472ab	460ab	128ab	135ab	60.24ef	61.90 e	9.64ef	9.90 e
50cm^3 Nemastop	450 b	433 b	143 a	150 a	64.35cd	66.33cd	10.30cd	10.61cd

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different.

Moreover, Bokhtiar, (2011) reported that, Si amendment increased yield in dry matter (26 to 70%) and in yield (30 to 66%) on sugarcane, the higher yields due to Si application were correlated with higher leaf Si concentrations (Epstein, 1994). Silicon benefits to plants are

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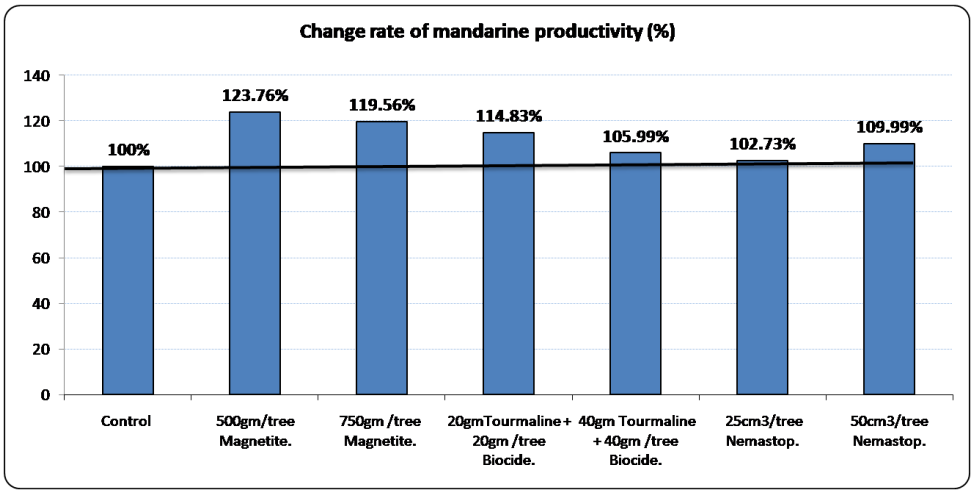

Fig.4. Average change rate of mandarin productivity (%) during two seasons (2015 and 2016) as influenced with some natural materials.

expressed by increasing their resistance to attack by insect pests, nematodes and diseases as well as by reducing their transpiration rate by controlling the stomata opening and closing mechanism, which provides further tolerance to water shortages during periods of low soil moisture (Korndorfer, *et al*., 2002).

Fruit quality. (Table 4) reflected Juice fruit quality (Juice weight %, T.S.S %, Acidity %, T.S.S/Acid ratio and V.C mg. /100mljuice) as affected by Magnetite and some natural materials on mandarin trees. In general, all treatments improved fruit Juice quality during the two seasons especially Magnetite and Tourmaline treatments at different doses as compared with control treatment. Anyhow the results revealed that the differences between all treatments were low to be significant in the most cases in the first and second seasons (2015 and 2016), (Table 4). These results are in the same line with those obtained by (Ismail, *et al*., 2010) who found that, the application of 71.5 gm. Magnetite/ tree on grapevine grown in a newly reclaimed area was more effective in achieving the best values of both length and diameter berry, resulted in low total acidity in juice and high ratio of T.S.S / acid ratio. Also, (Taha, *et al*., 2011) revealed that, treated pepper plants with Magnetite at (4 g/pot) progressive increases in V.C and capsaicin contents. Also, our results indicated that, Biocide as a source of silicon improved fruit quality. Our results are in the same line with those obtained by (Hoda, *et al*., 2013) working on Valencia orange trees and stated that, Diatoms as a source of silicon could earlier the harvest date by increasing fruit T.S.S/ Acid ratio and Vitamin C contents and to decrease fruit acidity.

Economic study. In the economic study of yield production, the main economic criteria included cost of each substance (Magnetite, Tourmaline, Biocide and Nemastop) used under study(L.E /

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fed.), cost of labor (L.E / fed.), averages yield (ton / fed) for two seasons (2015 & 2016), price of yield over control (L.E) and net profit (L.E / fed.) for each treatment. Results are given in (Table 5). Other expenses such as the costs of supervision and royalties were not taken into consideration in this study. In more details unit price of Magnetite was (5 L.E / k.gm.), Tourmaline was (40 L.E / k.gm.), Biocide was (40 L.E / k.gm.) and unit price of Nemastop was (15 L.E / Liter) taking into account of all treatments were added in the soil under study. The study also revealed that the cost of labor that were used per treatment and thus the total costs were calculated. Also averages yield (ton / fed.) for the first and second seasons and yield over control were calculated, the price of mandarin yield is (1.5 L.E/ Kg.) and finally the net profit (L.E / fed.) for yield over control was determine. From this economic study it could be concluded that, application of 500 gm. Magnetite was the best treatment for achieving the highest net profit / fed. (3390 L.E) followed in descending order by using of Magnetite at 750 gm/ tree (2790 L.E) , Tourmaline at20gm/ tree plus Biocide at20gm/ tree (2115 L.E), Nemastop at 50cm^3/tree(1425 L.E) and so on as shown in (Table 5).

Table 4. Effect of Magnetite ore and other natural materials application on fruit quality of mandarin trees during two seasons (2015 and 2016).

	Juice weight (%)		T.S.S (%)		Acidity (%)		T.S.S/Acid ratio		V.C (mg./100mljuice)	
Treatments	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	46.1c	47.31d	10.2 b	9.83 c	1.21 a	1.15 a	8.38 b	8.53 e	23.15d	25.14d
500gm Magnetite	54.9 a	56.33a	11.3ab	12.17 a	1.18 a	1.24 a	9.60 a	9.82 a	30.50a	31.67a
750gm Magnetite	52.6ab	54.39b	11.6ab	11.3ab	1.22 a	1.19 a	9.43ab	9.50ab	30.17a	30.11b
20gm Tourmaline +20gm Biocide	52.5ab	53.33b	11.5ab	11.3ab	1.24 a	1.23 a	9.28ab	9.22bc	28.45b	29.5bc
40gm Tourmaline + 40gm Biocide	49.4bc	50.49c	12.2 a	11.00 b	1.35 a	1.23 a	9.16ab	8.91cd	25.75c	28.28c
25cm^3 Nemastop	49.3bc	48.35d	11.3ab	11.00 b	1.25 a	1.27 a	9.05ab	8.68de	23.77d	26.33d
50cm^3 Nemastop	48.9bc	50.89c	11.4 a	11.3ab	1.36 a	1.26 a	8.70ab	9.02cd	26.13c	28.8bc

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different.

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Table (5). Economic study for using Magnetite ore, Tourmaline, Biocide and Nemastop as natural materials on yield of Balady Mandarin trees.

Treatments	Total Q.of eachTrea./ fed.	Unit Price (L.E)	Cost of each Trea./fed. (L.E))	NO. Labor/ year	Labor fees (L.E)	Labor Cost (L.E)	Total cost trea./fed (L.E)	Average yield for Two seas. Ton/fed.	yield over control Ton/fed	yield over control Price (L.E)	Net Profit/ Fed. (L.E)
Control								9.51	-------		
500 gm Magnetite	80kg	5	400	2	50	100	**500**	11.77	2.26	**2260**	**3390**
750 gm Magnetite	120kg	5	600	2	50	100	**700**	11.37	1.86	**1860**	**2790**
20 gm Tourmaline + 20 gm Biocide	3.2 kg + 3.2 kg	40 40	128 128	2	50	100	**356**	10.92	1.41	**1410**	**2115**
40gm Tourmaline + 40gm Biocide	6.4 kg + 6.4 kg	40 40	256 256	2	50	100	**612**	10.08	0.57	**570**	**855**
25cm^{3}Nemastop	4L	15	60	2	50	100	**160**	9.77	0.26	**260**	**390**
50cm^{3}Nemastop	8L	15	120	2	50	100	**220**	10.46	0.95	**950**	**1425**

CONCLUSION

Plant parasitic nematodes cause serious crop losses worldwide and are among the most important agricultural pests (**Koenning *et al.*, 1999)**. The management of nematodes is more difficult than that of other pests because nematodes mostly inhabit the soil and usually attack the underground parts of the plants (**Stirling, 1991)**. Although chemical nematocides are effective, easy to apply, and show rapid effects, they have begun to disappear from the market in some developed countries owing to concerns about public health and environmental safety (**Schneider *et al.*, 2003).**

According to this study, reduction the population of citrus nematode (*Tylenchulus semipenetrans* Cobb) of Balady mandarin can be executed successfully by using different natural materials. 500 gm. of Magnetite ore was the best treatment for reducing the nematode and for achieving the best total yield and high fruit quality followed by either 20gm of Tourmaline ore / tree plus 20gm Biocide ore/ tree or 50cm^3 of Nemastop compound / tree .Moreover its application proved to be

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the best treatment for attaining the highest net profit per feddan . Also, it must be preferred the available material and least price in the market.

REFERENCES

A.O.A.C (1995). Official Methods of Analysis (A.O.A.C) Pub. By official A.O.A.C chapter 4, p.18-37, p.10, 44 p. 8-9.

Arab, R.; Dastan, S.; Mobasser, HR.; and Ghanbari-Malidarreh, A., (2011). Effect of silicon and cycocel application on yield components and quantity yield of rice (Oryza sativa L.) in Iran. Proc. of the 5th International Conference on silicon in Agriculture, 13-18,Beijing, China.

Abd-Elgawad M.M., (1995). Estimate of navel orange yield loss in *Tylenchulus semipenetrans* groves. *Egyptian Journal of Applied Science*, *10*: 6-14.

Badra, T. and EL-Gindi, D.M., (1979). The relationship between phenolic content and *Tylenchulus semipenetrans* populations in nitrogen-amended citrus plants**.** *Revue Nématol.* 2 (2): *161-164.*

Barker, K.R., (1985). Nematode extraction and bioassays. Pp. 19-35. *In*: An Advanced treatise on *Meloidogyne* - Vol. II (Barker K.R., Carter C.C. and Sasser J.N., eds). North Carolina State University Graphics, Raleigh, USA.

Bokhtiar, S. M., (2011). Effect of silicon on yield contributing parameters and its accumulation in abaxial epidermis of sugarcane leaf blade using energy dispersive x – ray analysis. Proc.of the 5th International Conference on silicon in Agriculture, 13-18, Beijing, China.

Cao H.B.; Li X.G.; Wu J.C.; Yu K.T., and Zhang, Y., (2003). Simulation of the effects of direct electric current on multispecies biofilms. Process Biochem. 38: 1139-1145

Charles, G.; Cranfield, A. D.; Vassil, K.; Rafal, E.; Dunin, B.; David de Pomerai and Jon Dobson (2014). Biogenic magnetite in the nematode Caenorhabditis elegans. *Proc. R. Soc. Lond.* B (Suppl.) 271, S436–S439

Clarke, G.M. and Kempson, R.E., (1997). Introduction to the design and analysis of experiments. Arnold**,** a member of the Holder Headline Group,1st Edt., London, UK.

Cohn E., (1972). Nematode diseases of *Citrus* spp. Pp. 215-244. *In*: Economic Nematology (Webster J.M., ed.). Academic Press, New York, USA.

Datnoff, L. E.; Rodrigues, F. A. and Seebold, K. W., (2007). Silicon and plant disease. In L. E. Datnoff, W. H. Elmer, & D. M. Huber (Eds.), Mineral nutrition and plant disease (p. 233-246). St. Paul: APS Press.

ISSN: 2455-6939

Volume:03, Issue:01

Duncan, D.B., (1955). Multiple ranges and multiple F-Test. *Biometrics*, *11*: 1-14.

Duncan, L.W., (2005). Nematode parasites of citrus. pp. 437-466. In Plant Parasitic Nematodes in Subtropical and Tropical Agriculture (Luc M, Sikora RA, Bridge J, eds). CAB International, Wallingford, UK.

Duncan, L.W.; Graham, J.H. and Timmer, L.W., (1993). Seasonal patterns associated with *Tylenchulus semipenetrans* and *Phytophthora parasitica* in the citrus rhizosphere. *Phytopathology* 83, 573–581.

Duval,J., (2004). The control of internal parasites in cattle and sheep. E.A.P. Publications. USA.

El-Sherif, A.G; Gad, S.B and Saadon, S.M., (2014). Eco-friendly Management of *Meloidogyne incognita* infecting Eggplant under Greenhouse Conditions.Asian Journal of Nematology 3(1):1-8.

Epstein, E. (1994). The anomaly of silicon in plant biology. Proc. Natl. Acad. Sci. USA Vol. 91, pp. 11-17.

Guo, J.B. and Qian, Y.Q., (1997). Hydrogen isotope fractionation and hydrogen diffusion in the tourmaline-water system. Geochim. Cosmochim. Acta. 61: 4679-4688.

Hoda, M. Mohamed; Faten, A. Al- Kamar and Azza, A. M. Abd-El-All (2013). Effect of Magnetite and Some Biofertilizer Application on Growth and Yield of Valencia Orange Trees Under El – Bustan Conditions. Nature and Science; 11(6), Pp 46 - 61

Horwitz, W. (1972). Official Methods of Analysis; Association of Official Analytical Chemists 11th ed. Washington, D.C.

Hung, G.C. and Rohde, RA. (1973). Phenol accumulation related to resistance in tomato infection by root knot and lesion nematodes. *J. Nematol.,* 5: 253-258.

Ismail, A.E.; Soliman, S.S.; Abd El- Moniem, E. M.; Awaad, M.S.; and Rashad, A.A. (2010). Effect of magnetic iron ore, metal compound fertilizer and bio-NK in controlling Root- knot Nematode in a newly reclaimed area of Egypt. *Pak. J. Nematol*., 28(2): 307-328.

Jin, Z.Z.; Ji, Z.J.; Liang, J.S.; Wang, J. and Sui, T.B. (2003). Observation of spontaneous polarization of tourmaline. Chin. Phys. 12: 222-225.

Josling, P.A. (2005). The heart of garlic nature's aid to healing the human body, HEC Publishing, Chicago Illinois. pp 20.

Kalyesa, R .(1975). Screening of indigenous plants for antihelminthic action against human *Ascaris lumbricoides*. Indian J. Physiol. Pharmacol. 19:47-49.

ISSN: 2455-6939

Volume:03, Issue:01

Kirschvink, J. L.; Kobayashi-Kirschvink, A. and Woodford, B. J. (1992). Magnetite biomineralization in the human brain. *Proc. Natl Acad. Sci. USA* **89**, 7683–7687.

Koenning, S. R.; Overstreet, C.; Noling, J. W.; Donald, P. A.; Becker, J. O. and Fortnum, B. A. (1999). Survey of crop losses in response to phytoparasitic nematodes in the United States for 1994. J. Nematol 31: 587–618.

Korndorfer, G. H.; Pereira, H. S.and Camargo, M. S. (2002). Papel do silício na produção de cana-de-açúcar. *Revista STAB*, v. 21, n. 1, p. 6-9.

Malick, C.P. and Singh, M.B. (1980). In Plant Enzymology and Histo Enzymology. Kalyani Publisher New Delhi, P 236.

Mansour, E.R. (2007). Effect of some culture practices on cauliflower tolerance to salinity under Ras Suder conditions. Msc. Thesis. Fac. Of Agric., Horticulture Dept. Ain Shams Univ.

Masamha.B; Gadzierayi,C.T and Mukutriwa,I. (2010). Efficacy of *Allium Sativum* (Garlic) in controlling Nematode parasites in sheep. Intern. J. Appl. Res. Vet. Med. Vol.8 No.3: 161-169.

Matsudo, T.; Asou, H.; Kobayashi, M. and Yonekura, M. (1993). Influences of magnetic fields on growth and fruit production of strawberry. *Acta Horticulturae* 348, 378–380.

Nakamura, T.; Fujishiro, K.; Kubo, T. and Iida, M. (1994). Tourmaline and lithium niobate reaction with water. Ferroelectrics, 155: 207-212.

Onyeagba, R.; Ugbogu, O.C.; Okeke, C.U. and Iroakasi, O. (2004). Studies on the antimicrobial effects of garlic (*Allium sativum* L.), ginger (*Zingiber officinale* Roscoe) and lime (*Citrus aurantifolia* L.). Afr. J. Biotechnol. 3:552-554.

Osman, H.A.; El-Gindi, A.Y.; Ameen, H.H.; Youseef ,M.M.A. and Lashein ,A.M. (2005). Evaluation of the nematicidal effects of smashed garlic, sincocin and Nemaless on the root-knot nematode, *Meloidogyne incognita* infecting cowpea plants. *Bulletin of The Egyptian National Research Center, 30*: 297-305.

Oteifa, B. and Tarjan, A.C. (1965). Potentially important plant parasitic nematodes present in established orchards of newly reclaimed sandy areas of the United Arab Republic. *Plant Disease Reporter*, *49*: 596-597.

Paxton, j. D. (1975).Phytoalexins, phenolics and other antibiotics in roots resistant to soil-borne fungi. In : Bruelh, G. W. (Ed.) *Biology and control of soil-borne plant pathogens,* St. Paul, Minnesota, U.S.A., American Phytopath. Soc.: 185-192.

ISSN: 2455-6939

Volume:03, Issue:01

Rezk, M. A. (1976). *Studies on plant parasitic nematodes attacking Graminae.* Ph. D. Thesis, Alex. Univ., 159 p.

Sasser, J.N. (1989). *Plant parasitic nematodes*: *the farmer's hiddenenemy*. North Carolina State University Graphics,Raleigh, USA, 115 pp.

Schneider, S. M.; Rosskopf, E. N.; Leesch, J. G.; Chellemi, D. O.; Bull, C. T. and Mazzola, M. (2003). Research on alternatives to methylbromide: preplant and post-harvest. Pest Manag. Sci. 59: 814–826.

Silva, R. V.; Oliveira, R. D. L.; Nascimento, K. J. T.; and Rodrigues, F. A. (2010). Biochemical responses of coffee resistance against *Meloidogyne exigua* mediated by silicon. Plant Pathology, 59, 586-593. http:// dx.doi.org/10.1111/j.1365-3059.2009.02228.x.

Southey J.F., (1970). *Laboratory methods for work with plant and soil nematodes*. Technical Bulletin of Ministry of Agriculture, Fishers and Food, London, 148 pp.

Stirling, G. R., (1991). Biological Control of Plant Parasitic Nematode: Progress, Problems and Prospects. CAB International, Wallington, UK.

Swain , B.N. and Prasad, J.S. (1988). Influence of silica content in the rice roots of rice varieties on the resistance of root – knot nematodes. Indian J. Nematol.18: 360-361.

Taha, B. A; Soha, E. Khalil and Ashraf, M.Khalil. (2011). Magnetic treatments of *Capsicum annuum L*. grown under saline irrigation conditions. Journal of Applied Sciences Research, 7(11): 1558- 1568.

Takahashi, E. and Miyake, Y. (1977). Silica and plant growth. In: Proceedings international seminar on environment and fertility management in intensive agriculture (SEFMIA), Tokyo, Japan, pp. 603-611.

Tanaka A, Park YD. (1966). Significance of the absorption and distribution of silica in the rice plant. Soil Sci. PlantNutr. 12: 191-195.

Yasser, M.A.; Emad, A.S., and Nermeen, T. Shanan. (2011). The use of organic and inorganic cultures in improving vegetative growth, yield characters and antioxidant activity of roselle plants (*Hibiscus sabdariffa* L.) African Journal of Biotechnology Vol.10(11), pp.1988- 1996.

