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EFFICIENCY OF USING MAGNETIZED WATER IN IMPROVING *MELOIDOGYNE INCOGNITA* CONTROL BY THREE CONCENTRATION OF *ALOE VERA* EXTRACT ON CUCUMBER PLANT

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Abstract

A trial experiment was conducted in order to study the effectiveness of the role of using magnetized irrigation water in raising the efficiency of the use of plant extract at three concentrations (ml/ml: in ratio 10, 20 and 40%) in the control of *M. incognita* at the level of 2000 eggs infecting cucumber under greenhouse conditions. All treatments showed remarkable increase in plant growth parameters as well as reduce nematode criteria. There was a positive correlation between the concentration level and tested plant growth and nematode criteria. The double coefficients of both plant extracts and magnetized water have yielded better results in improved tested plant parameters than alone did. The highest concentration of plant extract (40%) with magnetized irrigation water achieved the high values in the improvement plant criteria as well as reduction nematode population in soil and root with reproduction factor 0.7. The application of *Aloe* extract (10%) + M.W performed the best and showed maximum increase in total phenol followed by *Aloe* extract (20%) + M.W then *Aloe* extract (10%)+ with values of 215.3, 204.0 and 179.6 mg/100gm, respectively.

Key words : Cucumber, *Meloidogyne incognita*, control, *Aloe vera,* induced resistance, plant, leaves.

Introduction

Cucumber, *Cucumis sativus* L. (Cucurbitaceae) is one of the most important vegetable crops grown in Egypt. It is grown for domestic consumption either in the form of small green fruits eaten fresh or in the form of pickled fruits. The cucumber fruits have a quantity of dry substances ranging between 4-6%, which composed of carbohydrates, proteins, fibers and fats in addition to mineral salts. The fruits of the cucumber are poor in its content of vitamins, which contain a small amount of vitamin C and carotene. Additionally, the fruits of the cucumber contain a number of enzymes that help digest of fat and protein as well as its alkaline effect of mineral salts, which help to modify the acidity of the blood fluid on the one hand and also to dissolve the stones in the kidney and increase the urination on the other hand. During its various stages of development, the cucumber becomes infected with many animal pests and diseases that may limit its cultivation in certain areas. Nematodes, especially the root-knot nematode, *Meloidogyne incognita*, are the most dangerous agricultural pests that may prevent cucumber cultivation and reduce its productivity. *M. incognita*is one of the largest pests disturbing the world agricultural production, causing damage of about hundred billion dollars all over the world (Oka *et al*., 2000). Root-knot nematodes are obligate parasites and very harmful plant pests for restrictive the agricultural yield. The majority cultivated plant species are not resistance to root-knot nematode disease. During the last two decades, control of phytonematodes based on the use of nematicides but this caused environmental toxicity in addition to high chemical control costs. These have led to the search for other techniques to control these pests by using safe and environmentally friendly means (Pearce, 1997). The concept of stimulating plant resistance against plant pathogens has recently been demonstrated and several terms have been used to describe these, including acquired resistance, induced resistance and immunization. Induced resistance was defined as the process of stimulating or induction of plants to activate the role of physical and chemical defenses found naturally in plants

against plant pathogens using inducer factors. The latter was divided into bio-inducer factors consisting of plant growth factors rhizobaction and natural inducer factors that are represented in some plant extracts. There are many references in using compounds derived from different plant parts and their use as alternatives methods to synthetic pesticides (Blaske and Hertel, 2001 and Singh and Devi, 2012). Some plants contain natural materials that have no long soil effect and low toxicity to the plants as well as to reduce pest dispersal in agricultural lands (Shalaby, 2012). *Aloe vera* extract increase plant parameters such as the plant height, root length, fruit yield and shoot weight shown as well as showeda nematicidal effects on the root knot nematode, *M. incognita* (Jibia *et al*., 2014). The utilization of magnetic water in agriculture is a novel advance to rising the yield of numerous crops. Water coefficient has a positive effect on seed germination and plant growth development, maturity, yield and quality of many different crops (Aladjadjiyan, 2010). Improved in the enhancement, germination and output of the tested crops were accompanied by improvement in optical pigments (Hozayn *et al*., 2014), activates protein composition and activity enzymes (Celik *et al*., 2010), incites cell metabolism and vasectomy feeding cells of peas, lentils, onions and flax (Hozayn *et al*., 2015). Increase in economic return in the application of magnetic water treatments under field conditions were 144.8% in potatoes (Marinkovic *et al*., 2002); pepper by 64.9% (Takac *et al*., 2002) and soybean from 5 to 25%, with high amount of oil, protein and sunflower from 13.2 to 17.3% (Crnobarc *et al*., 2002). The current study aims to determine the role of using magnetized irrigation water in raising the efficiency of the use of plant extract in the control of plant nematodes parasitism under agricultural greenhouse conditions.

Materials and Methods

The Nematode Inocula

Indentified (J_2) of *M. incognita* (Kofoid & White) Chitwood were obtained from a pure culture of *M. incognita* initiated by a single eggmass propagated on coleus plants, *Coleus blumei* in the greenhouse. Nematode inocula extracted by sieving and modified Baermannmethod (Goodey, 1957) counted in a Hawksely counting slide under x 10 magnification by optical microscope.

Nematicides

AbamectinC48H72O14 (Avermectin B1a) + C47H70O14 (avermectin B1b).

Preparation plant extracts

Fresh plant leaves of *Aloe vera* were collected and then washed thoroughly with distilled water several times. 100 g of paper was added and 100 ml of distilled water was added in a sterile mixer. Mix the mixture for 10 minutes and place the converter in the centrifuge at 5000 rpm for 30 minutes. The liquid was filtered and filtered using filter paper and the filtrate was collected in a sterilized container. This was the 1: 1 water extract and the water extract was used in the experiment with concentrations (10, 20 and 40%).

Magnetized water

Magnetized water was obtained by passing irrigation water on the magnetized water apparatus(Half inch / 2000 salinity, inner diameter 3 cm - device length 60 cm – strong 5000 Gauss - flow rate 2 m^2/hour, apparatus weight 4 kg) Chinese-made.

Experimental design

The experiment was conducted under greenhouse condition (23±3°C) using the Randomized Complete Block Design with five replications for 10 treatments including: Magnetic water; *Aloe vera* extract (10%); *Aloe vera* extract (10%)+ Magnetic water; *Aloe vera* extract (20%); *Aloe vera* extract (20%)+ Magnetic water; *Aloe vera* extract (40%); *Aloe vera* extract (40%) + Magnetic water; Abamactine (0.2ml/pot); nematode check (nematode alone) and plant without nematode (Healthy plant). Fifty plastic pots (10 cm in diameter) filled in individually with one kg autoclaved soils (clay: sand; 1:1, v/v)and cucumber seeds cv. Beta 8were grown (3 seeds / pot). One week later, seedlings were reduced to one per pot and the addition of plant extracts and pesticide according to design of the experiment. After seven days, 2000 eggs of *M. incognita* were added for 8 treatments with consist of 45 pots.

Evaluation parameters for treatment efficacy

All plants related to each treatment were harvested up-rooted two months after growing cucumber seeds, and both of vegetative and root systems were used as fresh and dried tissues for the following efficacy evaluation analyses.

Plant growth parameters

The cucumber plant growth parameters including; fresh shoot lengths;fresh shoot and root weights (FWt); and shoot dry weight (DWt) were measured and reorded (AOAC, 2005).

Determination of nematode disease severity

Cucumberplant roots were examined galls formation and egg masses numbers using stereomicrscope after

staining in 0.01 acid fuchsin containing lactic acid (Byrd *et al*., 1983). The disease severity (DS)for nematode infection includingroot galling (RGI) and egg masses (REI) were measured depending of a scale of 0 to 5 according to Taylor and Sasser (1978) as: 0= no galls or egg masses; 1= 1-2; 2= 3-10; 3= 11-30; 4= 31-100; and 5= more than 100 galls or egg masses per root system.Vermiform stages of *M. incognita* were extracted from soil by usingthemethod of Goodey (1957) and then reproduction factor (RF) was calculated.

Biochemical analyses

Biochemical tests were performed at the end of experiment. Total phenols were estimated in 1g leaf sample using the method described by Malick and Singh (1980); crude proteins and nitrogen were estimated using the method of Robinson (1973). Total carbohydrates were estimated using the method of Hedge and Hofreiter (1962).

Statistical analysis

Data were analyzed to variance according to then compare means (Gomez and Gomez, 1984 and Duncan, 1955).

Results and Discussion

The effectiveness of using magnetized water in raising the efficiency of *A. vera* plant extract was studied in improving cucumber plant growth parameters under the stress of *M. incognita* infection within greenhouse conditions (table 1). It was clear that all tested treatments showed a significant increase in improved plant criteria ($P < 0.05$) with different degrees. In general, double coefficients of both plant extracts and magnetized water have yielded better results in improved plant parameters tested than either alone. It was clear that there was a significant increase in the tested plant parameters with increased concentration of plant extracts. On the other hand, the treatment with the highest concentration of plant extract (40%) with magnetized irrigation water recorded the high values in the improvement shoot length (41.1%), total plant fresh weight (40.7%) and shoot dry weight (39.3%) of cucumber, respectively (table 1). However, a moderately increase in length and total plant fresh and dry weights were detected with both plant extracts and magnetized water depending on extract concentrations. On the other hand, the application of magnetic water only (M.W.) showed the least increase in shoot length (7.6%), total plant fresh weight (12.0%) and shoot dry weight (1.8%), respectively in comparison with the check.

Table 1 : Role of utilization of magnetized irrigation water in raising the efficiency of the use of plant extract in improvement of cucumber cv Beta plant growth parameters under greenhouse conditions.

Treatments	Plant growth parameters									
	Length (cm.)		Total Plant Length	Inc.%	Fresh weight (g.)		Total plant fresh wt.	Inc.%	Shoot dry weight(g.)	Inc.%
	Shoot	Root			Shoot	Root				
Magnetic water	**10.2 c**	**16.6 c**	**26.8 c**	**7.6**	**5.4 bc**	**3.6 de**	**9.0bc**	**12.0**	**2.8bc**	**1.8**
ALOE extract (10%)	**10.3 c**	**17.6 c**	**27.9bc**	**12.0**	**6.1 b**	**3.7 de**	**9.8 bc**	21.0	**2.8bc**	**1.8**
ALOE extract (10%)+ M.W	**10.3 c**	**19.0 bc**	**29.3bc**	**17.7**	**6.5 b**	**4.9 cd**	**11.4 b**	67.9	**3.9 b**	**39.3**
ALOE extract (20%)	**11.0bc**	**17.6bc**	**28.6bc**	**14.9**	**6.3 b**	**3.7 de**	**9.1bc**	12.3	**2.8bc**	**0.4**
ALOE extract (20%)+ M.W	**11.6 bc**	**21.0 bc**	**32.6bc**	**30.9**	**6.3 b**	**6.3 bc**	**12.6 b**	55.6	**3.3 b**	**17.9**
ALOE extract (40%)	**11.6 c**	**20.6 bc**	**32.2 bc**	**29.3**	**6.0 b**	**4.6 d**	**10.6 bc**	30.9	**2.9 bc**	**3.6**
ALOE extract (40%)+ M.W	**13.6 bc**	**21.6 bc**	**35.2bc**	**41.4**	**6.5 b**	**7.1 b**	**13.6 b**	40.7	**3.9b**	**39.3**
Nematicide	**13.0 bc**	**23.0 b**	**36.0 b**	**44.6**	**6.6 b**	**3.4 e**	**10.0 bc**	23.5	**2.8 bc**	**1.8**
Nematode only	**9.6 c**	**15.3 c**	**24.9 c**	—	**4.1 c**	**3.9 de**	**8.1c**	0.0	**2.8bc**	**0.0**
Check	15.3 a	25.6 a	**40.9a**	**64.3**	9.1 a	8.9 a	**12.0 a**	**48.1**	4.6 a	**65.4**

M.W= Magnetic water

Each value presented the mean of five replicates.

Means in each column followed by the same letter(s) significantly are not different ($P<0.05$) by Duncan's multiple range test.

Table 2 : Impact of irrigation water in raising the efficiency of the use of plant extract on reproduction of *M. incognita* infecting cucumber under greenhouse conditions at 25 ± 3ºC.

Treatments	Nematode population in			No. of eggs/root	Total nematode population	RF*	N. of galls	GI**	N. of egg masses	EI**
	Soil/ pot	Root								
		Develop. stages	Females							
Magnetic water	90.0 bc	0.0 c	50.0 ab	5120.0c	5260.0 cd	2.6b	90.0ab	4.0b	50.0 abc	4.0a
ALOE extract (10%)	88.0 bc	0.0 c	50.0 ab	5030.0c	5168.0 cd	2.6b	50.0 ab	4.0b	48.0 abc	4.0a
ALOE extract (10%)+ Magnetic water	170.0bc	5.0 a	95.0 a	4429.0c	4699.0b	2.3b	94.0 ab	4.0b	48.0 abc	4.0a
ALOE extract (20%)	213.0 bc	4.0 ab	98.0 a	2338.0d	2653.0 cd	1.3c	98.0 a	4.0b	51.0 abc	4.0a
ALOE extract (20%)+ Magnetic water	80.0 bc	0.0 c	28.0 ab	1658.0d	1766.0 d	0.9e	24.0 ab	3.0c	21.0 abc	3.0b
ALOE extract (40%)	373.0 b	0.0 c	39.0 ab	1914.0 d	2326.0 cd	1.2c	36.0 ab	4.0b	11.0 bc	2.0c
ALOE extract (40%)+ Magnetic water	87.0 bc	0.0 c	23.0 ab	1335.0d	1445.0d	0.7e	23.0 ab	3.0c	9.0 bc	2.0c
Nematicide	0.0 c	0.0 c	0.0b	0.0e	0.0 d	0.0f	0.0 b	0.0e	0 c	0.0e
Nematode alone	5720.0 a	2.0 abc	99.0 a	18993.0a	24814.0 a	12.4a	99 a	5.0a	70.0 ab	4.0a

*Each value presented the mean of five replicates. M.W= Magnetic water

**Reproduction Factor (RF)= Final Population (Pf) /Initial Population (PI), Pi = 2000eggs of *M. incognita*, Pf = number of juveniles/pot+ no. of developmental stages + no. of females + no. of eggs/root). Means in each column followed by the same letter(s) significantly are not different (P<0.05) by Duncan's multiple range test.

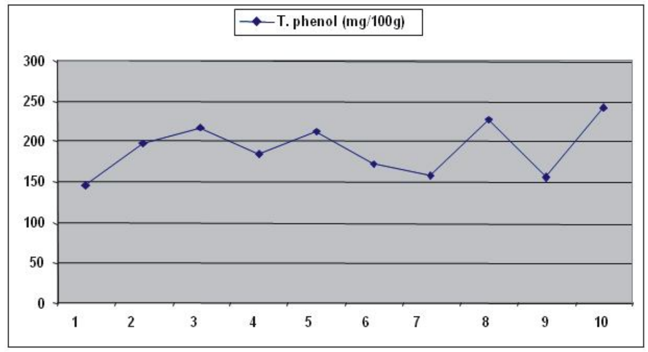

Fig. 1 : Total phenol content in leaves of cucumber infected with *M. incognita* as affected by irrigation water in raising plant extract.

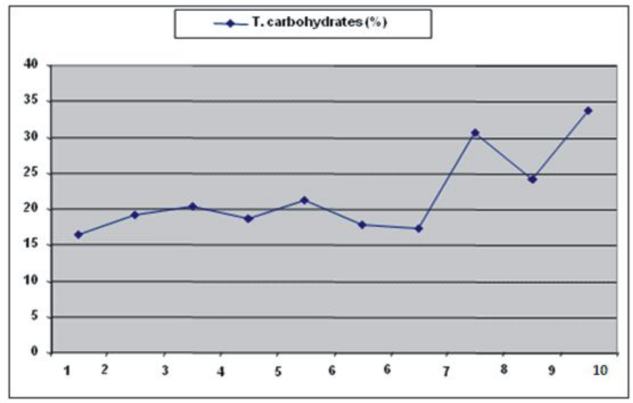

Fig. 2 : Percentage of total carbohydrate in leaves of cucumber infected with *M. incognita* as affected by irrigation water in raising plant extract.

Data in table 2 elucidate the suppressive effect of magnetized water in raising the efficiency of *Aloe vera* plant extract on reduction nematode multiplication whether in soil or root of cucumber. A significant reduction in root-knot nematode, *M. incognita* populations with reproduction factor ranged from 0.7 to 2.6 vs. 12.4 for nematode alone. It was evident that *M. incognita* population was significantly suppressed in double application of magnetized water and *Aloe vera* plant extract when compared to nematode alone. The highest reduction in total nematode population in soil and root was recorded with magnetized water and *Aloe vera* plant extract at high concentration (40%) with reproduction factor 0.7, respectively. Similar trend was noticed with gall formation (GI = 3.0) and egg masses number (EI= 2.0), respectively. Conversely, the application of magnetized water and *Aloe vera* singly sustained the greater nematode population (RF = 2.6 each) in comparison with untreated inoculated plant (RF = 12.4), gall formation (GI = 4.0 each) and egg masses number (EI = 4.0 each), respectively. It is worth to note that *M. incognita* root-knot nematode was significantly eradicated in root and soil following the application of

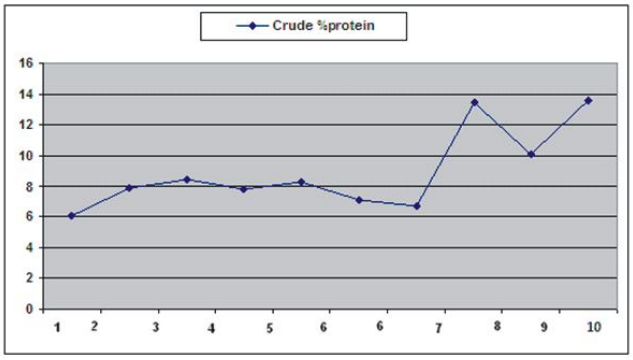

Fig. 3 : Crude protein content in leaves of cucumber infected with *M. incognita* as affected by irrigation water in raising plant extract.

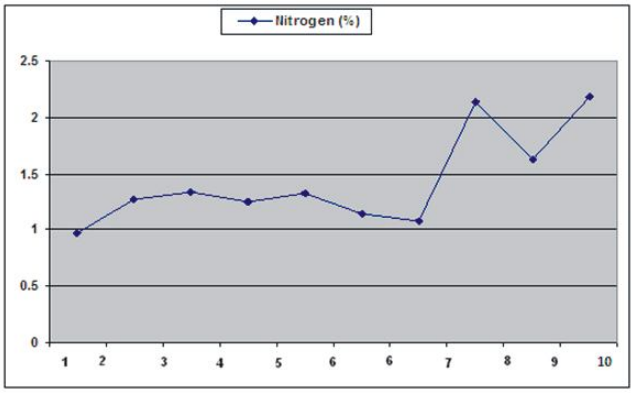

Fig. 4 : Percentage of nitrogen in leaves of cucumber infected with *M. incognita* as affected by irrigation water in raising plant extract.

the standard nematicide (RF = 0.0).

It was evident that the nematicide, showed maximum increase in chemical content in terms of total phenol, total carbohydrates, crude protein and nitrogen, in leaves of cucumber as compared to nematode alone with values of 221.3 mg/100gm 33.5, 13.9 and 2.17%, respectively. All application had no effect on total carbohydrates, nitrogen and crude protein compared to nematicide and untreated inoculated plants. Unless in certain treatments a detectable increase in total phenol was revealed compared to nematode alone. *Aloe* extract (10%)+ M.W performed the best and showed maximum increase in total phenol followed by *Aloe* extract (20%)+ M.W then *Aloe* extract (10%)+ with values of 215.3, 204.0 and 179.6 mg/100gm respectively (fig. 4).

Discussion

The increase in plants parameters such as the plant height, root length, fruit yield and shoot weight suggested that the extract of *Aloe vera* at three concentration (10, 20 and 40%) have potential nematicidal effect on the root knot nematodes *M. incognita*. There was a mark difference when compared with control treatments as well as a positive correlation between the concentration level and tested plant growth and nematode criteria. The present data in accordance with Jibia *et al*. (2014) in respect to plant extracts of *A. indica* leaf, C. *annuum* fruit, *Z. officinale* rhizome, *P. biglobosa* seed on the micro plots that suppressed the population root knot nematodes infecting cucumber. In the mean time the degree of nematode population reduction was dependent on the rate of application of different concentration of the extracts and time of exposure, inhibition of *M. incognita* reproduction resulted in significant improvement in the cucumber growth parameters and yield, a similar report by Ramesh *et al*. (2008). The chemical effect of *A. vera* plant may be due to chemical compounds that may be toxic to nematodes. The phytochemical screening of *A. vera* showed the presence of tannins, flavonoids, terpenoids, carbohydrates, alkaloids (Raphael, 2012). Moreover, Umar (2013) stated that botanical extract that contained alkaloids or flavonoids either singly or in combination inhibited of *Meloidogyne* spp. Saponins possessed cell membrane-breaking property and making the cells more permeable and at the same time more fragile, enabling a loss of cell contents through leakage (Bassetti and Sala, 2005). Alkaloids in plants have been reported to exhibit nematicidal activity on root-knot nematodes (Chitwood, 2003). Phenolics have been reported to show toxicity to insects, fungi, bacteria, nematodes and weeds (Koul, 2008). Tannins inhibit pathogenic fungi and also have anthelmintic, antimicrobial properties; whereas alkaloids have antimicrobial, anthelmintic and antidiarrhoeal abilities (Tiwari *et al*., 2011). The nematotoxic effect of the extracts may also be attributed to their high contents of certain oxygenated compounds which are characterized by their lipophilic properties that enable them to dissolve cytoplasmic membrane of nematode cells and interfering with enzyme protein structure (Claudius-Cole *et al*., 2010). 'The mechanisms of many plant extracts may include denaturing and degrading proteins, inhibition of enzymes and interfering with the electron flow in respiratory chain or with ADP phosphorylation (Claudius-Cole *et al*., 2010). The highest concentration of plant extract (40%) with magnetized irrigation water achieved the high values in the improvement plant criteria as well as reduction nematode population in soil and root with reproduction factor 0.7. The possibility of using magnetized water to desalinate the soil is accounted for the enhanced dissolving capacity application in agricultural fields can improve the quality of agricultural water, resulting better agricultural production. Auxiliary the present study shows

that magnetic water demonstrated high efficiency in improving the role of plant extracts in improving plant parameters under nematode infection as well as improved plant quality (total phenol, total carbohydrates, crude protein and nitrogen). These finding are in accordance with Hozayn *et al.* (2017), who revealed that magnetic water enhanced seed quality (crude protein and fiber). Adding magnetic water to soil may also influence soil PH that changing it from slightly alkaline to slightly acidic, thus solubility of micronutrients be increased around peanut roots improving its nutritional status. The yield of peanut infected with nematodes increased in magnetic water treatment compared to that of peanut infected with nematodes and irrigated with normal water. The peanut yield increased in magnetic water regardless of nematode infection. This may be attributed to improve the nutritional status of peanut at magnetic water, thus increasing tolerance of peanut to nematode infection. Increasing the nematode juveniles (J_2) at harvest in the soil of magnetic water treatment may be also due to improve the nutritional status of plants supplying nematodes with more food, thus nematode females lay more eggs and progeny (Hozayn *et al*., 2017). The ready availability of role magnetic water in enhance safe natural materials for environment that used in the nematodes control to reduce the usage of high toxic pesticides such plant extract that used in this study, its effects on nematode population, plant growth and yield suggest the need for additional studies in the field to evaluate the efficacy and economics for it use in nematode management.

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