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Effect of Magnetic Water on Adult Emergence of *Etiella zinckenella* (Treitschke) Pupa and Root -Knot Nematode (*Meliodogyne incognita*) Chitwood

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ABSTRACT

A trial study was conducted to evaluate the impact of using magnetized sea water MSW on the adult emergence of *E. zinckenella* and to monitor the effect of MSW on *M. incognita* infecting cowpea plant. A total numbers of *E. zinckenella* pupa were incubation on plastic containers including soil irrigation with MSW in three concentrations. Although results indicated that, the magnetic concentrations were low, the mortality rate of the *E. zinckenella* pupa was high on the other hand, when the concentrations increased, the total mortality was increased. Total mortality of pupal stage was 13.75 %, 32.5% and 41.25 %, respectively when, using of magnetic sea water in concentrations 10, 20 and 40 ml.t compared with untreated treatment.In addition, this experiment was carried out to evaluate the effects of magnetizing irrigation water on naturally growing of cowpea infected with root-knot nematode *M. incognita* in sandy soil at three concentrations 10, 20 and 40 ml.t. The obtained results indicated that irrigation cowpea plants with magnetic water induced positive significant effect on the most of studied parameters. The percentage improvement ranged between 63.33, 78 and 97.97, 94.59 in fresh and dry weight.

Keywords: Magnetism, *Etiella zinckenella*, *Meliodogyne incognita*, Pupa, Cowpea

INTRODUCTION

Lima bean Pod borer, *Etiella zinckenella* (Treitschke) (Lepidoptera:Pyralidae) is a cosmopolitan pest of worldwide distribution (Qu and Kogan, 1984). It attacks cultivated legumes including cowpea, garden pea (*Pisum sativum*), Lima bean, mung bean, pigeon pea, common bean (*Phaseolus vulgaris*) and soyabean. *Etiella zinckenella* causes about 40% yield loss in soyabean in the province of lorestan and in adjacent areasin Iran (Parvin, 1981). *Etiella zinckenella* caused 40% yield loss in cowpea in Egypt (Copr, 1981). Larvae of *E. zinckenella* can cause severe damage to many species of beans, feeding inside the pods on the seeds. Each larva can damage several seeds during its development. Studies have reported overall damage to pigeon pea crop at 25-40% in china, and up to 80% in Egypt. On a per seed basis, reported damage rates vary from 12% to 15-44% in Indonesia and Brazil, respectively (The food & Environment Research Agency, 2013).

New approaches for nematode management are to maintain nematode population density at level that does not cause economic damage and/or to increase the plant tolerance to nematode infection. Root-knot nematods are obligate parasites and very damaging plant pests for limiting the agricultural productivity. Most cultivated plant species are susceptible to root-knoot nematode infection. In Egypt, root-knot nematodes, *Meloidogyne* spp. are becoming a real threat to almost all vegetable crops, especially in the newly reclaimed areas and they have been considered as limiting factor, in crop production (Ibrahim *et al.* 2000). Because of the lack of resistance in plants to most species of root-knot nematode as well as the environmental restrictions on nematicidal using for controlling plant parasitic nematods; biological control and other ecofriendly disease control measures have gained recently increasing interest. On the other hand, it has been suggested that the use of induced resistance in plants could offer a considerable potential for biological control (Deverall, 1995).

Therefore, scanty information is available concerning effect of magnetic water on *E. zinckenella*, this current research aimed to detect the ability of magnetized sea water on the mortality percentage of *E. zinckenella* pupa and in addition, period of pupal stage and to maintain nematode population density at level that does not cause economic damage.

MATERIALS AND METHODS

***Etiella zinckenella*:**

Cowpea pods damage with larvae of *E. zinckenella* were collected from farm of Agriculture College, Mansoura University (Dakhlia, Egypt). Damage of pods were kept in jars at 26±2^{O}C and 65±5% RH. Then separated *E. zinckenella* pupae were transferred in plastic containers (0.5 x10 cm) covered with muslin for ventilation until the emergence of the adult. The magnetized sea water was prepaired in physical department faculty of science, Mansoura University. The magnetic flux in the middle center of bottles was measured with the tesla-meter. The magnetic field recorded 10, 20 and 40 milli-tesla (ml.t). Total numbers of 80 *E. zinckenella* pupae with three replicates in each treatment were incubation on plastic containers including soil irrigation with (MSW) in three concentrations 10, 20 and 40 (ml.t). Investigation and recording results were carried out 1, 3, 5 and 7 days after adult emergence from the pupal stage in the untreated treatment and compared with it then calculated the percentage of pupal mortality.

Source of Nematode:

Second stage juveniles (J2) of *M. incognita* were obtained from apure culture initiated by single egg-mass and propagated on coleus plants, *Coleus blumei* in the green house of Nematology Research unit, Agricultural Zoology Department, Faculty of Agricultural, Mansoura university, Egypt. Where this work was carried-out.

Impact of irrigated with three concentrations of magnetic treatment in comparison with non magnetic water against *Meliodogyne incognita* infecting cowpea plants:

In order to study the effect of irrigated magnetic at three concentrations (10, 20 and 40 ml.t) each in comparison with tap water on controlling *M. incognita* infecting cowpea plants, four kilograms of the sterilized clay loam soil were weighted into perforated plastic post of 20 cm diameter and 30 cm depth. The post were perforated to avoid water logging five seeds of the cowpea were planted into each of the plastic pot and later themed down to one healthy plant per pot. The post was replicated three times in a completely randomized design.

After two weeks of planting each of the cowpea plants was inoculated with 6000 (j2) of *M. incognita* into 5 cm holes in the soil, around the plants as close as possible to the roots. Two weeks after inoculation (4 weeks after planting) 5 mls of the various concentration of the magnetic sea water treatments 10, 20 and 40 ml.t were irrigated.

Untreated plants inoculated with nematodes nonmagnetic water. Data dealing with plant length, fresh weights of shoot and root, shoot dry weight were determined and recorded. Infected cowpea roots of each concentration per each nutrient mineral/replicate and nematode alone were washed with tap water separately fixed in 4% formalin for 24 hrs and stained in acid fuchsin (Byrd *et al.,* 1983) and examined with stereoscopic microscope for the number of galls, eggmasses, developmental stages and females of *M. incognita* recorded. Then data on eggs/eggmasses, root galls, females, eggmasses number per one gram of infected root/replicate of each treatment was calculated and recorded. *M. incognita* (J2) was extracted from soil/ plastic bag in 100g/ replicate through sieving and modified Baermann technique (Goodey, 1957) counted by Hawksely counting under x10 magnification microscope, recorded and calculated for each bag (4.5 kg) soil.

Toxicity test:

A completely randomized experiment with three treatments irrigation the reared container with magnetized sea water with three conc. 10, 20 and 40 ml.t each treatment have three replicates was conducted in laboratory to follow the number of non-emergence adult after 1, 3, 5 and 7 days compared with the control treatment. Death corrected ratio was computed 1, 3, 5 and 7 days after treatment according to Abbott's formula (1925).

Data analysis:

Nematoda experimental data were analyzed with one-way analysis of variance (ANOVA). Comparisons of means of non-emergence adults were made with the Duncan's Multiple Range Test (Costat Software, 2004).

Table 1. Physical and chemical analysis of soil.

Particle size distribution				**Textural**	**Ec**	**PH**	**Caco3**	**O.M**	**Sp**
Coarse	Fine	Silt	Clay	Class	**Dsm^{-1}**	**1:2.5**	**(%)**	**(%)**	**(%)**
Sand 2.97	Sand 19.33	47.16	30.54	Clay loam	1.5 0.88	8.09	3.65	1.79	61.9
Available element, ppm					DTPA extractable ppm				
N		P		K	Fe	Zn	Cu	Cd	
61.8		6.75		Mn 178.2	3.66	1.97	0.29	0.92	

RESULTS AND DISCUSSION

Toxicity effect of *E. zinckenella* pupae:

Efficiency of magnetic water on *E. zinckenella* pupa:-

The date in Table (2) demonstrated that, although the magnetic concentrations were low, the mortality rate of the *E. zinckenella* pupa was high and when the concentrations increased, the total mortality increased. Total mortality of pupal stage was 13.75 %, 32.5% and 41.25 % respectively when, treatment with magnetic water in concentrations 10, 20 and 40 ml.t compared with control treatment.

Table 2. Percentage mortality of *E. zinckenella* pupa treated with magnetic water in different concentrations

Treatment	**Conc. (ml.t)**	**Percentage of non emergence of *E. zinckenella* pupae.**				**Total Mortality %**
		One day	**Three days**	**Five days**	**Seven days**	
Magnetic water	10	0	0	40	15	13.75%
	20	0	80	25	25	32..5%
	40	0	85	45	35	41.25%
untreated		5	0	0	0	5.00%

Hussein *et al.* (2017) reported that there was a clear and significant effect for the magnetism to kill and minimizing mite populations. While, Table (3) and Figure (1) indicated that LC_{50} was 52.19 and LC_{90} was 43.19. The probability was 0.215.

Hussein *et al*. (2015) investigated the effect of magnetic field on the physiological aspects of some insects, larvae of three insects which cotton leafwarm, *Spodoptera littoralis*, red palm weevil, *Rhynchophorus ferruginous* and the greater wax moth, *Galleria mellonella* were rearing under laboratory condition.

Results showed that each of body weight and growth rate as well as the physiological aspects were affected the magnetic field. A pplication rate of growth decreased in cotton leafworm and red palm weevil. The invertase enzyme decreased in the treated larvae of *S. littoralis* and *G. mellonella* with 40.15% and 28.33% respectively lower than the control. Basalova *et al.* (2016) reported that the response to magnetic fields (MFs) in some insects e.g. cockroaches is depending on photosensitive Cryptochromes (cry) and directly affect the visual system through the gene function.

Table 3. Efficiency of magnetic water against *E. zinckenella* pupae.

Treatment Conc.(ml.t)	**Corrected Mortality%**	**LC 50**	**LC 90**	**Slope ±S.D.**	**R**	**P**
10	13.75	52.19	431.90	1.396 ±0.324	0.965	0.215
20	32.5					
40	41.25					

R: Regression P: Propability

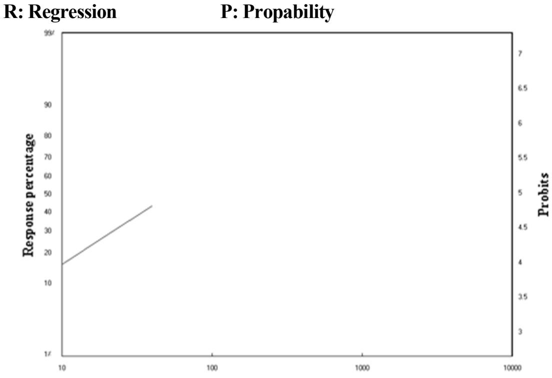

Fig .1. LC - P line for magnetized water treated with *E. zinckenella* pupa.

Effect of magnetized water on *M. incognita* and the tested plant parameters:-

Data listed in Table (4) and Fig. 2 showed the efficacy of three levels of sea water magnetization (10, 20 and 40 ml.t) on the reproduction of root-knotting nematodes *M. incognita* infecting cowpea plants, as compared with control. Results showed that there was a positive correlation between the increase in water magnetization level and the reduction rate of tested nematode parameters, as the level of 40 ml.t of magnetic water recorded the highest values of the reduction of the developmental stages (93.93%) females (9.0%) nematodes in soil (90.53%) galls (98.04%) and eggmasses numbers (96.95%) respectively as compared to tape water. While the application of low level of 10 ml.t of magnetic water treatment recorded the lower reduction values in this respect.

Table 4. Parameters of nematode *M. incognita* infecting cowpea plants as influenced by irrigated magnetic water at three concentrations in comparison with tap water.

Treatment		Average number of nematode in						No. of Galls 1g/root	Red%	RGI	No. of eggmasses 1g/root	Red%	E.I*
		One gram root				100g/soil	Red%						
		D.s	Red%	females	Red%								
Magnetic water	10ml.t	12.0	95.04	23.0	92.77	250.0	83.09	34.0	93.35	4.0	22.0	91.60	3.00
	20ml.t	10.0	95.87	15.0	95.28	202.0	86.33	24.0	95.30	3.0	14.0	94.66	3.00
	40ml.t	5.0	97.93	9.0	97.17	140.0	90.53	10.0	98.04	2.0	8.0	96.95	2.00
Tap water		242.0	0.0	318.0	0.0	1478.0	0.0	511.0	0.0	5.0	262.0	0.0	5.0
L.S.D. 0.05		3.04	-----	4.69	-----	225.8	------	6.17	-------	------	4.59	--------	--------

N=6000$J_2$of *M. incognita* **D.S = Development stages**

Each value is the mean of five replicates.

**** Root gall index (RGI) or egg-masses index (EI) was determined according to the scale given by Taylor& 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.**

Figure 2. Effect of certain concentration of irrigated magnetic water on *Meloidogyne incognita* infecting cowpea plant cv.

(1=Tap water, 2=10 ml.t, 3=20 ml.t, 4=40ml.t)

On the other hand, the results listed in (Table 5) showed the effectiveness of three levels of sea water magnetization (10, 20 and 40 ml.t) on the tested plant parameters of the cowpea plant infected by *M. incognita* nematodes under agricultural conditions. It was evident that there was a positive correlation with increasing the level of magnetization of water and improved plant growth tested criteria. The application of high level of magnetic water (40 ml.t) treatment recorded the highest values in improvement of plant parameters for total plant length (60.5%), total plant fresh weight (97.97%) number of leaves (91.67%) as well as shoot dry weight (78.0), respectively as compared to tape water application.

Table 5. Plant growth response *M. incognita* infecting cowpea plants as influenced by irrigated magnetic water at three concentrations in comparison with tap water.

Treatments		Plant Growth Response											
		Length (cm)		Total	Red.%	Fresh weight (g)		Total F.W (g)	Red.%	Shoot D.W (g)	Red.%	No. of leaves	Red.%
		Shoot	Root			Shoot	Root						
Magnetic water	10ml.t	29.0	8.5	37.5	8.70	2.89	1.29	4.18	41.22	1.78	18.67	18	50.00
	20ml.t	40.0	12.0	52.0	50.72	3.95	1.81	5.76	94.59	2.45	63.33	21	75.00
	40ml.t	45.0	15.5	60.5	75.36	3.51	2.35	5.86	97.97	2.67	78.00	23	91.67
Tap water		30.0	4.5	34.5	0.0	1.98	0.98	2.96	0.0	1.5	0.00	12	0.0
L.S.D. 0.05		1.97	1.21	----	-----	1.35	1.08	-----	-----	1.06	-----	2.43	-----

N= 6000 eggs of *M. incognita* **- Each value is the mean of five replicates**

Means in each column followed by the same letter (s) did not differ at P< 0.05 according to Duncan multiple-range test -Number between parentheses represented the percentage of increase or decrease in plant growth response.

In fact, the use of magnetization technology for irrigation water has had a significant impact on the improvement of tested plant parameters with a clear reduction in the number of root-knot nematodes affecting cowpea yield. On the other hand, the increased concentration of water magnetism had a better effect than other rates. The present findings are in agreement of many researchers (Marinkovic *et al.,* 2002) who recorded an increasing in economic yield regarding application of magnetic water treatments under field condition reached to 144,8% in potato,; pepper by 64,9% (Kordas, 2002), broad bean and pea by 10 and 15%, respectively (Tian *et al.*, 1991).

Also, the root mass, leaf surface and yield of sugar beet treated with magnetized water increased by 94.0%, 52.0% and 12.88%, respectively (Vasilevski, 2003). Similar positive trends were obtained under Egyptian condition by Hozayn *et al*. (2013, 2014 and 2017), as they reported that the economic yield was increased (ton ha-1) in response to magnetized water application reached to 13.71% at wheat, 8.25% at faba bean, 21.8% at chick pea, 36.02% at canola, 22.37% at flax and 19.05% at sugar beet crop as compared to irrigation with tap water application. On the other hand the current findings are confirmed by Hozayn *et al.,* (2017) who stated that yield of peanut infected with nematodes increased in magnetic water treatment compared to that of peanut infected with nematodes and irrigated with non treated water. In other word, yield of peanut increased in magnetic water regardless of nematode infection. This may be improve the nutritional status of cowpea at magnetic water, thus increasing tolerance of cowpea to nematode infection. Increasing the nematode juveniles (J2) 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 (parents) lay more eggs

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تأثير المياه الممغنطه على عذارى دودة قرون اللوبيا *Etiella zinckenella* ونيماتودا تعقد الجذور *Meloidogyna incognita*

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معهد بحوث وقاية النباتات – مركز بحوث الزراعيه الدقى - الجيزه

تم دراسة تاثير ثلاثة تركيزات من مياه البحر الممغنطه هي(10، 20، 40 ملى تسلا)علي كلا من عذارى دودة قرون اللوبيا وتأثير تلك المعاملات علي الإصابه بنيماتودا تعقد الجذور *Meloidogyne incognita* والنباتات المعامله أوضحت النتائج مايلي:- بمتابعة الفحص وتسجيل النتائج بعد 1 ،3 ،5 ،7 يوم من خروج الحشرات الكامله فى معاملة الكنترول ان هناك تاثير مميت على خروج الحشرات الكامله من العذارى التى وضعت فى تربه مرويه بماء البحر الممغنط بتركيزت مختلفه من المغنطه وهى 10 ،20 ،40 ml.t حيث كانت نسبة الموت فى الحشرات الكامله داخل العذارى هى 13.75، 32.5 و41.25 % على التوالى وهذا يدل ان جميع التركيزات لها تأثير مميت على الحشرات الكامله داخل العذارى وكلما ذاد التركيز ذاد معدل موت الحشرات الكامله . كما اوضحت النتائج ان التركيز النصف مميت للحشرات الكامله داخل العذارى هو 52.19% بينما التركيز الذى يقتل 90 % من المعامله هو 431.90%. أدت جميع التركيزات المختبره الي تحسن معنوي ف مقاييس النمو النباتية المختبره مع خفض واضح في مقاييس النيماتودا المختبره بدرجه كبيرة لحد ما. كانت المعاملة عند تركيز 40 هي الأفضل يليها المعاملة بتركيز 20 في معدلات الزيادة للمقاييس النباتية المختبرة مثل الوزن الجاف والمجموع الخضري 78، 63.33% و97.97، 94.59 % علي التوالي وكانت المعاملة بتركيز 10 الاقل في قيمة الوزن الجاف للمجموع الخضري بمعدل 18.67 و 41.22 %. لوحظ اتجاه مشابه في معدلات خفض مقاييس النيماتودا المختبره مثل تعداد النيماتودا الكلي ف التربه بمعدلات 90.53، 86.33 و83.06 علي التوالي لنفس التركيزات السابقة. بالاضافه لخفض معدل العقد وكتل البيض الموجوده علي الجذور بمعدل 98.04، 95.30، 93.04% و 96.95، 94.66، 91.60% لكل منهما علي التوالي.