

Interaction of Static Magnetic Fields (SMF) with Biology of *Tetranychus urticae* Koch (Acari)

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ABSTRACT

A laboratory experiment was conducted to study the effects of Bio-assay of the economic mite; *Tetranychus urticae* Koch by the levels of static magnetic field forces. Completely randomized experiment with three replicates was designed. Similar groups of eggs of *T. urticae* were exposed to the odd numbers of magnets; 1,3 and 5 units (0.14- 4.0 ml.t.) and even numbers of magnets; 2,4 and 6 (2.6-4.24 ml.t.). Check was left without magnetizing. The observations included, egg hatchability percentage, incubation period, life cycle, longevity, life span, survivability, mean number of eggs / female and sex ratio of the 1st generation. Results showed that there was a linear negative relationship between the force of magnetic field and the percentage of egg hatchability. Hatching eggs were decreased from 100 % in the check to 90.3% in 6 magnet unit's treatment. Also mean number of eggs and longevity decreased from 4.0 eggs & 16.9 days to 2.3 eggs & 11.4 days; while incubation period and life cycle were prolonged depending on the number of magnet pieces from 7.0 & 15.7 days to 8.4 & 12.0 days, respectively of the above-mentioned magnets exposure.

Key words: Magnetic field, Biology, *Tetranychus urticae*.

INTRODUCTION

By the present time there are extensive researches which show the influence of weak magnetic fields (MF) on processes of embryonic development of various species of animals.

The effects of magnetic fields induction are different in nature and magnitude from the interaction of materials with static magnetic fields. Investigation of weak magnetic fields action on insects and microorganisms is carried out for the last dictates in different countries (Yim and Jeony, 2006). The magnetic fields affect yeast growth (Kimball, 1938), bacteria sensitivity (Jihen *et al.*, 2010) protozoa and other microorganisms orientation (Brown 1962 and Jin *et al.*, 2006).

The effects of magnetic fields on arthropods specially insects were studied by Levenegood and Shinkle, 1960 and Biljana *et al.*, 2001 on *Drosophila* size of wing, Aphid molting, development and fecundity (Haline *et al.*, 1964 and Juan He *et al.*, 2012 and Giraldo *et al.*, 2013), activity and aging of honeybees (Martin *et al.*, 1988), behavior (Leucht, 1984). Mosquito egg hatching (Pan and Liu, 2004) and egg hatchability and development of four economic insects (Hussein *et al.*, 2014) and metamorphosis of the meal worm beetle (Ermakov and Ledven, 2010), orientation of insects (Maeda *et al.*, 2008; Geo & Zhai, 2010 and Paz *et al.*, 2012). The magnetic fields also affect chordates; fishes behavior (krylov *et al.*, 2013), orientation of reptiles and bird's migration (Schneider *et al.*, 1994) and some mammals development and growth like mice (Bamathy, 1963 a, b & c; Bellossi, 1986 and Sathon

et al., 1996). Effects of magnetic fields were also studied on snails orientation and metabolism (Brown *et al.*, 1959; Brown & Hultrerr, 1960 and Brown & Webb, 1960). Reports on the effect of magnetic fields on plants were found on seed germination and growth (pitman, 1963 & 1964; Ginzo & Decima, 1995 and Wang *et al.*, 2008). About mites, no available references so far have been obtained in literature on the effects of magnetic fields interaction with mite biology of *Tetranychus urticae* Koch, which is considered the most famous and destructive acari pest to economic crops and protected houses.

The aim of this investigation was to study the effects of static magnetic fields as one of the new approaches to control phytophagous mites. Effects of different levels of static magnetic fields on *T. urticae* development, fecundity, hatchability and sex ratio of the first generation were studied.

MATERIALS AND METHODS

As the eggs of pests represent the weakest stage along their life cycles, this lab. experiment aimed to investigate the effect of the magnetic fields on the hatchability, life cycle, fecundity and sex ratio of *T. urticae* Koch first generation individuals.

T. urticae were collected from castor leaves *Ricinus communis* L. from the farm of Faculty of, Agriculture, Cairo University.

Individuals of *T. urticae* were mass-reared in the laboratory on fresh leaves of *Acalypha* (*Acalypha marginata*) arising on moisten cotton wool in aluminum trays (30x 20x 7cm) provided with water.

Tangle-foot of mixture of Canada balsam and both castor and citronella oils surrounding the edges of the tray was applied to prevent the mite from escaping.

The trays were supplied with enough individuals of *T. urticae* different stages under room conditions. Water was added when needed to maintain suitable moisture. Groups from 25 eggs *T. urticae* were transferred to Acalypha. Leaf discs (2x 5cm diameter) placed on cotton bed in Phil dish 20 x15 cm). The cotton bed was kept wet by soaking with water twice daily so that the discs remained fresh. Ten *T. urticae* adult females collected from the laboratory stock cultures were transferred to each disc for laying eggs.

For Experiments on effect of magnetic field on *T. urticae* biology, 30 newly deposited eggs of the same age were transferred to a leaf disc (2x5cm). Every dish contained 0,1,2,3,4,5,6 magnets. Dishes of the odd numbers of magnets 1, 3 and 5 were fixed along the first generation besides the control (without magnetic field). *T. urticae* reared dishes of the even numbers of magnets 2, 4 and 6 magnets, also fixed besides another dish as a control. For both the important bio- assay parameters: egg hatchability, life cycle, longevity, fecundity and survival rate were calculated.

Three replicates from each treatment dishes were kept in room condition with temperatures (22+ 2 °C) and 65+5%.R.H.

The used magnets were fixed around the dishes of mite rearing by the four directions (front, back, left and right sides) . All magnets used were completely similar in their magnetic field (14-16 mlt.) for each. Values of magnetic flux density in the center of dishes were measured using Tesla meter (TM204) apparatus manufactured by MCP lab. Electronics company, China. The magnetic field for each rearing dish was measured in 2 directions: The first when nodal of the apparatus parallel with (front – back) direction and the second with (left – right) direction. The 2 values and their average were calculated (Table 1).

RESULTS AND DISCUSSION

Table (1) indicates to the two measured values of the magnetic flux density for each treatment as well as their calculated average value. The table indicated to a positive relationship between numbers of magnet pieces and the magnetic field (ml.t.). The average values ranged between 0.14ml.t. to 4.25 ml.t., when one magnet piece to 6 pieces of magnets were used, in comparison with the control treatment which had no magnet pieces and zero MF, Table 1. It is important to have a clear idea of what magnetism

means, magnetism is the attraction of one object to another. This applies to anything with any mass, including people. Although everything has a magnetic field, only metal can be magnetized when an object is not magnetized. The charge it contains appears something like instable, when an object is magnetized, its electrons are aligned in lines. An object has a charge when all of its electrons are aligned in the same direction. Also, this gives a magnet two poles, a north pole and a south pole. If one attempts to put two north poles or two south poles together, they will not connect. North is only attracted to south and vice versa (Rosanna, 2012).

Table (2) shows the values of the different bio-assay parameters of the treatments affected with the odd numbers of magnet pieces 1, 3 and 5 magnets. Results showed that, each of the life cycle of *T. urticae* as well as incubation period of eggs were positively influenced by the presence of magnets number. All other measured parameters were negatively influenced with increasing the magnets pieces.

In respect of eggs, it was noticed that numbers of eggs per female under 1, 3 and 5 magnet pieces decreased to 3.8, 2.7 and 3.1 eggs /female respectively in comparison with 4 eggs in the control. In the same time eggs hatchability percentage decreased to 60, 54.5 and 75.8 % in comparison with 100% in the control. In the contrary, eggs incubation period increased under the same pre-mentioned treatments to 13.66, 12.45 and 10.33 days in comparison with only 7.0 days in the control. Our results are coming along with those of Hussein *et al.*, 2014, who reported that four economic insects; *Sitotroga cerealella*, *Trichogramma evanescens*, *Spodoptera littoralis* and *Spodoptera exigua* percentage of egg hatchability was in linear negative relationship with the force of the magnetic field. The life cycle considerably increased to 28.6, 25.7 and 23.7 days respectively in comparison with 18.4 days in the control. In verse, the calculation of the life span indicated that there was slight decrease as it recorded 32.7, 33.5 and 33.8 days in comparison with 35.1 days for the control.

Both longevity and survivability recorded decrease in their values when the magnet numbers increased. Longevity values recorded only 3.5, 7.8 and 10.1 days in comparison with 16.7 days in the control. Survivability percentage recorded only 34.5, 76.6 and 39.5 %; while it was 100% in the control.

Table (2) also, indicates that the abundance of *T. urticae* females decreased in the pre-mentioned treatments as the sex ratio recorded 66, 51 and 60%, respectively; while it was 87% in the control

Table (1): The measured magnetic flux density in the investigated treatments

No. of magnet pieces MF values	Control	One magnetizer	Two mags.	Three mags.	Four mags.	Five mags.	Six mags.
1 st direction	0	0.17	5	7	10	7.5	8
2 nd direction	0	0.10	0.2	1.6	1.5	0.5	1.5
(\bar{X}) average value	0	0.14	2.6	4.30	5.75	4.0	4.25

Table (2): Effect of odd magnetizer on biological parameters of *Tetranychus urticae* Koch

Parameter Treatments	Mean effectiveness of magnets							Sex ratio %
	Hatchability %	Incubation period (days)	Life cycle (days)	Longevity (days)	Life span (days)	No of eggs/♀/day	Survivability %	
Control	100	7.0 ±1.92	15.7±3.02	16.9±1.87	32.6±3.6	4.0±0.9	100	86.2
One magnetizer	60	13.7± 2.59	28.6±2.07	3.5±0.96	32.1±2.8	3.8±1.4	34.5	66
Three mags.	54.5	12.5± 2.13	25.7±3.41	7.8±1.54	33.5±3.1	2.7±0.7	76.6	51
Five mags.	75.8	10.3 ±1.96	23.7±2.96	10.1±1.76	33.8±4.2	3.1±0.9	39.5	60

Table (3): Effect of even magnetizer on biological parameters of *Tetranychus urticae* Koch

Parameter Treatments	Mean effectiveness of magnets							Sex ratio %
	Hatchability %	Incubation Period (days)	Life cycle (days)	Longevity (days)	Life span (days)	No of eggs /♀/ day	Survivability %	
Control	100	7.0 ±1.92	15.7±3.02	16.9±1.87	32.6±3.61	4.0±0.9	100	86.2
Two magnetizer	88.3	14.0±3.13	18.7 ±2.69	10.0 ±2.23	28.7 ±3.34	2.6±0.9	100	59.4
Four mags.	62.5	12.7 ± 2.97	14.6 ±3.11	17.0 ±2.45	31.5±2.96	2.9 ±0.8	62.5	60.7
Six mags.	90.3	8.4±2.35	12.0 ±1.78	11.4 ±2.35	23.4 ±3.14	2.3±0.4	75.0	65.2

treatment. The environmental effects of magnetic field are becoming of increasing importance, the interaction of the electromagnetic field with a biological system is complex (Barnothym, 1964). Static magnetic fields (SMF) as a type of environmental pressure are capable of affecting a number of biological systems (Arthur, 2003). The influence of SMF-s –treated on aphid *Sitobion avenae* indicated to a significant negative effect on survival rate, fecundity and life expectancy under the exposure of 0.176T for 30 min. and 0.065T for 60 min. (Juan He 2012).

Nabeel, 2010 studied the effect of magnetic field on the number of eggs of the two mites; *Polyphagotarsonemus latus* and *T. urticae*. The number of eggs was highly affected by the time of exposure. These results give us an idea that the magnetic field may be enhancing some metabolic enzymes inside the mites.

Data in Table (3) indicated to the values of pre-mentioned parameters under treatments of the even numbers of magnet pieces 2, 4 and 6 magnets, in comparison with the control (OMF). The same trend of influence was noticed, number of eggs per female decreased to 2.6, 2.9 and 2.3 eggs in comparison with 4.0 eggs for control. Also, decreasing of eggs hatchability was emphasized as it recorded 88.3, 62.5 and 90.3 %, respectively in comparison with 100% in the control. Egg incubation period was elongated to 14, 12.7 and 8.4 days, respectively; while it was only 7.3 days in the control .

Either the life cycle or life span under 2, 4 and 6 pieces of magnets were slightly influenced in comparison of the control. Life cycle recorded 17.8, 14.6 and 12 days compared with 13 days for control. Life span values recorded 28.7, 31.6 and 23.4 days against 30.1 days in the control.

Each of longevity and survivability were negatively influenced with presence of magnets. Period of longevity recorded 10, 17 and 14 days under 2, 4 and 6 magnets, respectively in comparison with 17.1 days in the control. The survivability percentage recorded 100, 62.5 and 75 %, respectively; while it was 100% in control. Data also referred to decreasing in *T. urticae* females numbers as the sex ratio recorded 59.4, 60.7 and 65.2% in comparison of 85.4 % in control the treatment .

In conclusion of our results, we can announce that magnetic fields affect in one way or another biology of the two spotted spider mite *T. urticae*. As the magnet power increase, the egg hatchability, longevity and mean number of eggs/females/day decrease. Meanwhile; it prolonged incubation period and life cycle compared to the cheek. We suggest that static magnetic field power could be an element of the new approaches represented in the integrated management of *T. urticae*.

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