

IMPACT OF MAGNETIC FIELDS AND TEMPERATURES ON BIOLOGICAL, LIFE TABLE, MORPHOLOGICAL AND BIOCHEMICAL PARAMETERS IN *EARIAS INSULANA* (BOISD.)

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(Manuscript received 3 April 2018)

Abstract

Under laboratory conditions, the spiny bollworm, *Earias insulana* (Boisd.) adult stage field strain were exposed to two magnetic fields (28.6 & 2.21 mt) and temperature levels (30 & 18°C) to study some aspects of the pest acts in biological, life table, morphological and biochemical assays as affected by the treatments used. Data obtained of *E. insulana* adult female biological aspects revealed that increasing in pre-oviposition period in the most treatments used as well as post-oviposition period; vice versa was happened with oviposition period. The same trend found in adult female longevity that increasing in the most treatments and contrary in male adult longevity. Eggs laying of treated adult female had sever reduction especially in high magnetic field and high temperature treatments as well as fertility and fecundity. First generation of treated adults affected by increasing in larval and pupal duration, reduction and mortalities as well as pre-oviposition period in the most treatments. Also, life table parameters of *E. insulana* affected by magnetic field and temperature treatments. Female progeny/female (Mx), survival rate (Lx), net reproductive rate (Ro), intrinsic rate of natural increase (r_m), finit rate of increase (e^{rm}) and sex ratio had decreased in the most treatments. Contrary was happened with generation time (T) and doubling time (DT) that had increased in the most treatments compared to control. All biochemical determinations of *E. insulana* adult had reduction of total protein, free amino acids, total lipid, total carbohydrate, Alanine aminotransferase (ALT/GPT), Aspartate aminotransferase (AST/GOT) and phenoloxidase that reflects to depress malformations in different stages especially in temperature at level 30°C. From all previous, the high magnetic field and temperature were more effects on *E. insulana* adults than low magnetic field and temperature.

Key words: *Earias insulana*, Magnetic, temperature, biology, life table, morphology, biochemical.

INTRODUCTION

In Egypt, up till now, The spiny bollworm (SBW), *Earias insulana* (Lepidoptera: Noctuidae) is one of the most dangerous pests attacking many plants of Malvaceae family, especially cotton, (*Gossypium spp.*) and causing severe damage the maximum

damage was 67.7 and 52.4% for fruits and buds, leads to high loss in both quality and quantity of cotton yield (Amer, *et al.* 2015).

However, under field conditions, it was found a certain physical environment as temperature and magnetic fields; the temperature is a critical biotic important factor affecting the development, survival, population dynamics and seasonal fluctuation of this pest on different host plants in the field (Tran *et al.*, 2007). Many studies indicated that different temperature degrees had high effects on the development and viability of various insects. Kandil (2013) reported that temperature effects on some biological and biochemical aspects of *Earias insulana* field strain.

On the other hand, the interaction of the electromagnetic with a biological system is complex. In addition, static magnetic fields (SMF) as a type of environmental pressure are capable of affecting a number of biological systems. Most of the studies about MFs' effects have focused on vertebrates and relatively fewer studies have been done on insects and their stored-product environment (Starick *et al.*, 2005). The static magnetic fields had an apparent effect on insect egg hatching; the hatching was delayed by the strong static magnetic fields and the delay non-Linearly increased with the intensity of the magnetic field. The larval development in the strong magnetic field was slower than in the geomagnetic field Barrya, *et al.* (2017); meanwhile, the same authors mentioned that the measurement of the magnetic field can give more direct determination of axonal current than the measurement of voltage. Knowledge's of electro physiological parameters such as neuronal or bath conductivities may be possible to measure current flow through non-axonal processes such as the soma and dendrites and computing in complex neuronal systems.

Life tables consider as a prediction style about population development of the pest or other insects. The present experiment has predicate about the effect of magnetic field on the tested *Earias insulana* to clarify and understanding the impact of tested factor on the growth, survival, reproduction and increase rate of *Earias insulana* population (Amer, *et al.* 2015).

Aim of the present work is to examine the effects of two constant temperature (30 & 18°C) and magnetic field (28.6& 2.21 mt) on some biological, life table, morphological parameters and biochemical assays of *E. insulana* treated as adult moth field strain.

MATERIALS AND METHODS

A. Insect used.

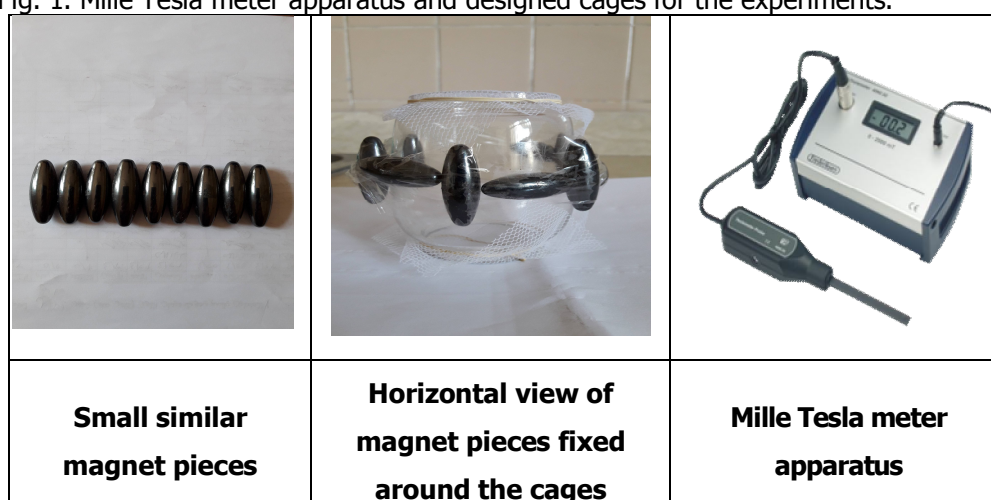
Field strain of spiny bollworm, *E. insulana* was reared under the laboratory conditions at 26±1°C and 65-70 R.H. at Bollworms Research Department, Plant

Protection Research Institute, Agriculture Research Center on artificial diet as described by **Rashad and Ammar (1985)**.

B. Adjusting and creating the magnetic field.

The magnetic field as created by using a small similar magnet pieces; 1.5 cm long for each (12 pieces for 28.6 mt and 5 pieces for 2.21 mt) that were arranged and fixed around the rearing cages (as demonstrated bellow) with strength of milli Tesla (mt), which was measured with mille tesla meter apparatus (Faculty of Engineering Menofiya University) as shown in figure (1).

Fig. 1. Mille Tesla meter apparatus and designed cages for the experiments.



C. Insect's preparation for treatments.

Five groups of *E. insulana* freshly emerged moths; each group 15 pairs ($\sigma \times \text{♀}$) divided into three replicates; each replicate ($5\sigma \times 5\text{♀}$) was confined in a glass chimney cage (17 cm height and 7.12 cm in diameter); inside each cage, a piece of cotton soaked in 10% sugar solution was immersed to be renewed 48 hr for moths' nutrition. The top and bottom of each cage were covered with screening mesh kept in position by rubber bands for stimulating eggs laying response in the females. Eggs were deposited through the screening mesh, one piece of paper placed upper and lower the cages in open petri-dish that served as an oviposition site eggs. The eggs were collected daily and kept until hatching.

D. Biological aspects.

The 1st group, 15 pairs of newly emerged adult were used in 3 replicates; each replicate ($5\sigma \times 5\text{♀}$) in glass cage under the previously mentioned rearing condition were exposed to lower magnetic power adjust margined (2.21 mt. in lower and 1.36 mt. in center jars).

The 2nd group exposed to high magnetic power (28.6 mt in lower and 1.45 mt in center). 15pairs of newly emerged adult were used in 3 replicates; each (5♂ X 5♀) in glass cage under the same condition.

The 3rd group; 15 pairs of newly emerged adult were used in 3 replicates; each replicate (5♂ X 5♀) in glass cage under the previously mentioned rearing at low temperature 18±1°C and 75±5 R.H.

The 4th group; were reared at high temperature 30±1°C and 75±5 R.H., 15 pairs of newly emerged adult were used in 3 replicates; each replicate (5♂ X 5♀) in glass cage.

The 5th group; were reared at 26±1°C and 75±5 R.H., 15 pairs of newly emerged adult were used in 3 replicates; each replicate (5♂ X 5♀) in glass cage used as control.

Cages were examined daily to investigate the pre-oviposition, oviposition and post-oviposition periods, females and males longevity; also, number of eggs laid, hatchability, fecundity and sterility%.

Hatchability percentage. It was calculated according to Zidan and Abdel-Megeed (1987) as follows:

$$\text{Hatchability\%} = \frac{\text{No. egg hatchability in check} - \text{No. egg hatchability in treatment}}{\text{No. egg hatchability in check}} \times 100$$

Fecundity percentage. It was calculated according to Crystal and Lachance (1963) as follows:

$$\% \text{ Fecundity} = \frac{\text{No. eggs/ treated female}}{\text{No. eggs/ untreated female}} \times 100$$

Sterility observed and corrected percentages. Were calculated according to **Zidan and Abdel-Megeed (1987)** as follows:

$$\% \text{ Sterility observed} = 100 - \text{Egg hatchability percentage}$$

$$\% \text{ Corrected sterility} = \frac{\% \text{ Sterility observed} - \text{Check}}{100 - \text{Check}} \times 100$$

Deposited eggs were collected daily and maintained at 26±1°C and 75±5 R.H. to investigate the duration, mortality and reductions % of egg, larval and pupal stages; also, pre-oviposition period.

Mortalities% were corrected according to Abbott's formula (1925).

Reduction %= % living in check-% living in treatment/ check X100 (Abbott, 1987).

E. Life table parameters.

Data of life table were analyzed by using life 48 basic computer program of (Abou

- Setta *et al.*1986). The program has output data include information for each interval of adult female age: (egg laying rate) (M), number of females alive at age x (L), mean female age at each interval mid-point (X), female progeny per female produced during the day (Mx), rate of survival (Lx). In addition, generation time (T), net reproductive rate (Ro), doubling time (DT), intrinsic rate of natural increase (r_m) and the finite rate of increase (e^{r_m}) and the number of times which the population multiplies in a unit time (doubling time, DT). Also, the sex ratio was calculated.

F. Biochemical assays.

The assays were done at Physiological Department; plant Protection Research Institute (P.P.R.I.). Samples of *E. insulana* treated and untreated adults were collected after 7 days from different treatments and homogenized in distilled water. The homogenates were centrifuged at 5000 r.p.m. at 5°C. The supernatants' were kept in deep freezer at -20°C till use for biochemical assays.

The colorimetric determination of total soluble protein, free amino acid, total lipids and carbohydrate in total homogenate of *E. insulana* adults that were estimated by the method of Bradford (1976); also, determination of Alanine aminotransferase (ALT/GPT) and Aspartate aminotransferase (AST/GOT) by the sensitive method of Waterhouse *et al.* (1961); whereas, Phenoloxidase activity was determined according to modification of Ishaaya (1971).

The recorded data values were statistically analyzed with one – way analysis of variance (ANOVA) ($P < 0.05$ %) (Snedecor, 1952) and Duncan multiple range test of means (Duncan, 1955) were used.

RESULTS AND DISCUSSION

A. Affects of magnetic field and Temperature degrees on some biological aspects of *E. insulana*.

Adult moth of *E. insulana* were exposed to high and low magnetic field (28.6 & 2.21 mt); in addition to high and low temperature degrees (30 & 18°C) to study different affects of the treatments on some biological aspects as following:

1. Oviposition periods.

Pre-oviposition period for *E. insulana* female lasted 4.5 and 3.6 days when exposed to high and low magnetic fields; while, it were 1.3 & 4.3 days, respectively when reared at 30 and 18°C, respectively compared with 2.8 days in optimum temperature of the control (26 °C) (Table, 1).

The oviposition period lasted 5.0 and 9.6 days when exposed to high and low magnetic fields; while, the female moth spent 4.0& 13.7 days, respectively, when reared at 30 and 18°C, respectively compared with 13.7 days in optimum temperature

(26 °C) (Table, 1). This result agree with recorded by Kandil (2013) that oviposition period of *Earias insulana* had high decreased with increasing in the temperature tested; also, Said, *et al.* (2017) found that high magnetic flux (28.2 mt) had high reduced of oviposition period for females of *Pectinophra gossypiella* 2 times than control.

On contrast, high magnetic and low temperature caused increasing the Post oviposition period to 7.0 and 6.3 days, followed by low magnetic field and high temperature (4.1 & 3 days) compared with 2.6 days in optimum temperature of the control (26 °C).

It can be concluded that temperature at 30 °C caused decreasing in pre-oviposition period approximately to half time of the control nearly and oviposition period to 3 times compare with optimum temperature (26 °C).

2. Adult longevity.

Data in Table (1) showed the shortest period adult female longevity that was 8.3 days and 4.6 days/ male at 30°C, but it prolonged to 24.3 days/ female and 20.3 days/ male at 18°C. In addition, there was negative relationship between temperature and the longevity of female and male. But in case of magnetic treatments appeared no significant different between the longevity periods for both adults and control. These results agree with Kandil (2013) that mentioned the mean adult longevity of *Earias insulana* decreased with increasing in the temperature tested.

3. Fecundity and sterility.

Results showed a significant reduction in the number of deposited eggs per each treated female. The mean numbers of deposited eggs were 49.3 and 93.0 eggs/female exposed to high and low magnetic field; while, it were 39.3 and 63.0 eggs /female treated with high and low temperatures, respectively as compared with in untreated 172.0 eggs/female.

Also, the percentage of hatchability was high affected by the treatments. The hatchability percentages were 62.7 and 86.0% for eggs deposited by females exposed to high and low magnetic field treatments, respectively and high decreasing to 45.0 and 60.7% for eggs deposited by females treated with high and low temperatures compared with untreated (92.6%) as mentioned in Table (1).

Fecundity percentages were 28.7, 54.1, 22.8 and 36.6% for high & low magnetic fields and high & low temperatures, respectively (Table 1).

High and low temperatures (30 & 18°C) caused the highly observed sterility (55 & 39.3%), followed by high and low magnetic fields (28.6 & 2.21 mt); the observed sterility were 37.3 & 14%, respectively compared with sterility observed in control (7.4%) as tabulated in Table (1).

Starick, *et al.* (2005) found that the influence of level magnetic had high effected on the fecundity and behavior of *Rhyzopertha dominica* (Fabricius). Also, the exposing of *Ephestia kuehniella* (Zeller) adults to increase levels of MFs had influenced their daily egg production; there was a significant reduction in progeny production. In addition, the values of fecundity were few when the adults of exposure to high temperatures and no eggs were laid by adults of *Heliothis armigera* (Hubner) when exposed to 40, 42.5 and 45 °C.

Table 1. Impact of magnetic field and temperatures on some biological aspects of adults' *E. insulana*.

Biological aspects	Optimum temp. (26°C) (Control)	Magnetic levels		Temperature degrees		L.S.D _{0.05}
		High MF1	Low MF2	High temp	Low temp	
Pre- oviposition (days)	2.8 ^b	4.5 ^c	3.6 ^b	1.3 ^a	4.3 ^c	1.258
Oviposition (days)	11.3 ^b	5.0 ^a	9.6 ^b	4.0 ^a	13.7 ^c	2.115
Post- oviposition (days)	2.6 ^a	7.0 ^c	4.1 ^b	3.0 ^a	6.3 ^c	0.689
♀Longevity (days)	16.7 ^b	16.5 ^b	17.3 ^b	8.3 ^a	24.3 ^c	1.344
♂Longevity (days)	12.9 ^b	10.3 ^b	11.3 ^b	4.6 ^a	20.3 ^c	1.688
Eggs/female	172 ^e	49.3 ^b	93.0 ^d	39.3 ^a	63.0 ^c	4.890
% Egg reduction	-	71.3 ^a	45.9 ^c	77.2 ^a	63.4 ^b	9.871
%Egg hatchability	92.6 ^c	62.7 ^b	86.0 ^c	45.0 ^a	60.7 ^b	6.872
% Egg hatchability reduction	-	32.3 ^b	7.13 ^c	51.4 ^a	34.4 ^b	12.421
% Fecundity	100	28.7 ^c	54.1 ^a	22.8 ^c	36.6 ^b	2.985
% Sterility observed	7.4 ^c	37.3 ^b	14 ^c	55 ^a	39.3 ^b	12.63
% Corrected sterility	-	32.3 ^b	7.13 ^c	51.4 ^a	34.4 ^b	12.21

MF1: high magnetic (28.6 mt) = (28.6 mt. in lower and 1.45 mt. in center jars).

MF2: low magnetic (2.21 mt) = (2.21 mt. in lower and 1.36 mt. in center jars).

4. Eggs incubation.

Data presented in Table (1) show that the incubation period of *E. insulana* eggs deposited by adult females that exposed to high and low magnetic were 4.9 & 3.9 days, respectively. On the other hand, the egg incubation period was 5.0 days when *E. insulana* adult moth treated at 18 °C; while, at 30 °C the incubation time was shortened to 1.6 days. Significant differences were found between the incubation

periods of eggs as related to temperature and high magnetic, it indicated that embryonic development of *E. insulana* eggs was affected with high magnetic and two tested temperatures.

Starick, *et al.* (2005) recorded that the effects of 7 mt MFs on egg hatching of *Ephestia kuehniella* (Zeller); the hatching of the eggs at 7 mt was delayed and hatching rate reduced.

Table 2. Impact of magnetic field and temperatures on some biological aspects of 1st generation treated as adults' *E. insulana*.

Biological aspects	Optimum temp. (26C°) (Control)	Magnetic levels		Temperature degrees		L.S.D _{0.05}
		High MF1	Low MF2	High temp	Low temp	
Larval duration of 1 st g (days)	14.3 ^b	19.0 ^{ab}	15.0 ^{ab}	4.6 ^c	21.0 ^a	6.034
Pupal duration of 1 st g (days)	7.3 ^b	8.0 ^b	7.6 ^b	3.1 ^c	13.0 ^a	3.82
% Larval mortality of 1 st g	6.0 ^d	22.0 ^c	35.0 ^b	37.0 ^b	48.0 ^a	7.865
% Larval reduction of 1 st g	-	17.0 ^c	31.0 ^b	33.0 ^b	45.0 ^a	6.258
% Pupal mortality of 1 st g	2.0 ^d	8.0 ^c	13.0 ^{ab}	15.0 ^b	18.0 ^a	2.12
% Pupal reduction of 1 st g	-	6.0 ^c	11.0 ^b	13.0 ^b	16.0 ^a	2.123
Pre-oviposition period of 1 st generation (days)	2.6 ^b	3.1 ^{ab}	2.8 ^b	1.6 ^b	5.4 ^a	1.30

MF1: high magnetic (28.6 mt) = (28.6 mt. in lower and 1.45 mt. in center jars).

MF2: low magnetic (2.21 mt) = (2.21 mt. in lower and 1.36 mt. in center jars).

g: generation.

5. Larval and Pupal durations.

Data in Table (2) illustrated that larval and pupal durations of *E. insulana* treated as adult moth by high or low magnetic and temperature degrees were affected.

Larval duration had slightly increased to 19 and 15 days in high and low magnetic treatments, respectively compared with control (14.3 days); the last value of untreated increased to 21 days in low temperature treatment; meanwhile, the larval duration of *E. insulana* had depressed to 4.6 days as affected by high temperature treatment. The same trend was found in pupal duration parameter as described in Table (2).

Said, *et al.* (2017) recorded that magnetic flux high effected on larval and pupal durations and reduction the total eggs laid by female of *Pectinophra gossypiella* (Boisd.).

6. Reduction and mortality percentages.

Larval reduction percentage was 17% as a result of adult moth treatment at high magnetic field (28.6 mt). This percent increased to 31% at low magnetic field. While, larval reduction increased to 33 and 45% as a result of adult moth treatment at high (30°C) and low (18°C) temperatures as described in Table (2). The same trend was found in pupal reduction percentages; it's were 6, 11, 13 and 16% for high magnetic, low magnetic, high temperature and low temperature treatments, respectively. The same trend was found in larval and pupal mortality percentages.

7. Pre- oviposition period of 1st generation.

Adult female moth pre-oviposition period of the first generation as a latent effect that resulted from treated adult moth by two levels of magnetic or temperatures were represented in Table (2) affected by increasing the pre-oviposition period of *E. insulana* adult female moth to twice nearly in low temperature treatment (18 °C) (5.4 days) compared to control (2.6 days). Contrary was happened in high temperature treatment (30°C). Whereas, both high and low magnetic treatments had slightly increased the pre-oviposition (3.1 & 2.8 days, respectively) compared to control.

Kandil (2013) reported that mean larval duration was 3.54 days at 33 °C and 14.7 days at 26°C for *E. insulana*. Also, the larval duration decreased as temperature increased when reared on okra pods. Said, *et al.* (2017) found that the high magnetic flux elongated the pre and post- oviposition period for females of *Pectinophra gossypiella*.

B. Life table parameters of *E.insulana*.

1. Female progeny/female (Mx) and rate of survival (Lx).

Figures (2) showed that female progeny/female (Mx) of untreated *E. insulana* ranged between 4 to 11.25, while the last values drastically decreased in treated females, especially by treatment of high temperature; it ranged between 1.65 to 4.29 female progeny/female, followed by high magnet power (Mx: 3.85 to 9.17 female progeny/female) and low magnet power (Mx: 1.50-8.44 female progeny/female). Moreover, it ranged between 2.87 to 11.28 females progeny/female in low temperature treatment compared to control.

The (Lx) parameter (rate of survival) ranged between 0.37 to 0.92 times in *E. insulana* untreated females (Figure 2). The Lx of females treated as adult emergency moth by high temperature ranged from 0.12-0.31 times. While, at high magnet power treatment, Lx ranged from 0.14 to 0.35 times. On the other hand, at low temperature treatment, survival rate ranged from 0.14 to 0.36 times. Also, survival rate of females developed from first generation of adult moth treatment of *E. insulana* treated by low magnet power had survival rate ranged between 0.38 to 0.63 times.

2. Generation time (T).

E. insulana, treated as emergency adult moth by high temperature, spent a generation time of 11.02 days as in Table (3) that had drastically decreased compared to control (29.5 days), followed by high magnet power treatment that had generation time (33.3 days). While, treatment of low temperature caused increased in generation time (43.5days) compared to control. Treatment of low magnet power had generation time nearly as the same result of control (29.4 days).

3. Net reproductive rate (Ro).

The treatments of high temperature, high magnet power and low temperature caused high reduction in female capacity to increase the population in each generation when *E. insulana* was treated as emergency adult moth as shown in Table (3), especially in high temperature treatment (Ro: 3.74, 9.63 & 9.89 females/ female in one generation for high temperature, high magnet power and low temperature, respectively), followed by low magnet power treatment that had net reproductive rate 26.4 females/ female in one generation compared to the untreated *E.insulana* (76.8 females/female).

Table 3. Life table parameters of *E. insulana* treated as moth with magnet and temperatures.

Treatments	T (days)	(Ro)	Increase rate		DT (days)	Sex ratio
			r_m	e^{rm}		
Control	29.5 ^a	76.8 ^a	0.15 ^a	1.16 ^a	4.621 ^b	0.5 ^a
High magnet (28.6 mt)	33.3 ^a	9.63 ^c	0.069 ^a	1.07 ^a	10.05 ^{ab}	0.55 ^a
Low magnet (2.21 mt)	29.4 ^a	26.4 ^b	0.11 ^a	1.12 ^a	6.301 ^b	0.45 ^a
High temperature (30 °C)	11.02 ^b	3.74 ^c	0.12 ^a	1.13 ^a	5.776 ^b	0.33 ^a
Low temperature (18 °C)	43.5 ^a	9.89 ^c	0.052 ^a	1.05 ^a	13.18 ^a	0.41 ^a
L.S.D. 0.05	14.94	8.725	0.145	1.694	5.578	0.5102

(T) = The generation time

(Ro) =The net reproductive rate

(r_m) = The intrinsic rate of natural increase (e^{rm}) = The finit rate of increase

(DT) = The doubling time

4. Increase rate.

4.1 Intrinsic rate of natural increase (r_m).

Table (3) shows that intrinsic rate of natural increase (r_m) where the ability of inheriting increase of *E. insulana* untreated female was 0.15 times/female/day. While, the females treated as emerged adult female moth with high magnet power and low temperature reduced r_m values to 0.069 and 0.053 times/female/day. On the other hand, treatments of low magnet power and high temperature had the least reduction in intrinsic rate (0.11 and 0.12 times/ female/ day).

4.2 Finit rate of increase (e^m).

Daily population of untreated *E. insulana* had increased to 1.16 times/female/day as represented in Table (3). Also, the females developed from emergency adult female moth treated with high magnet power and low temperature had capacity 1.07 and 1.05 times/female/day that had decreased in finit rate of increase. While, the low magnet power and high temperature degree had 1.12 and 1.13 times/female/day that close to the control value.

5. Doubling time (DT).

The time for population to become twice, that mean doubling time (DT) depends on the intrinsic rate of natural increase (r_m) which could be affected by many factors as the rate of survival, generation time, female in progeny and fecundity. *E. insulana* in the control (non-treated) had populations that multiply every 4.621 days as in Table (3). These days increased to 5.776 and 6.301 days when *E. insulana* treated as emergency female moth by high temperature and low magnet power treatments, followed by the exposure to high magnet power that had 10.05 days. While, low temperature treatment had the highest increase where 13.18 days to multiply.

6. Sex ratio.

Sex ratio was calculated as females/ total. In control (non-treated), it was 0.5. This ratio in case of the spiny bollworm treated as emergency adult female moth with high temperature, low temperature and low magnet power, decreased 0.33, 0.41 and 0.45, respectively, compared to control. While, sex ratio after the treatment of high magnet power, had sex ratio (0.55) close to control value as shown in Table (3).

Life table studies are essential tools for understanding population dynamics (Behnaz, *et al.* 2015). This Technical brief is a short summary of the results obtained from the trials conducted to understand the pest dynamics at different temperature. Most researchers seem to agree that warmer temperatures in temperate climates will result in more types and higher populations of insects. Hence, it is important to understand the population growth of the important insect pests. The measurement of insect developmental, survival and reproductive responses to temperature poses practical challenges because of their modality, variability among individuals and high mortality near the lower and upper threshold temperatures. The intrinsic rate of increase, finite rate and mean generation time, net reproductive rate of *H. armigera* were highly affected at 29 °C than 25 °C. (Behnaz, *et al.* 2015).

Fig. 2. Effect of magnet and temperature on female progeny/ female (Mx) and survival rate (Lx) of *E. insulana* female moths.

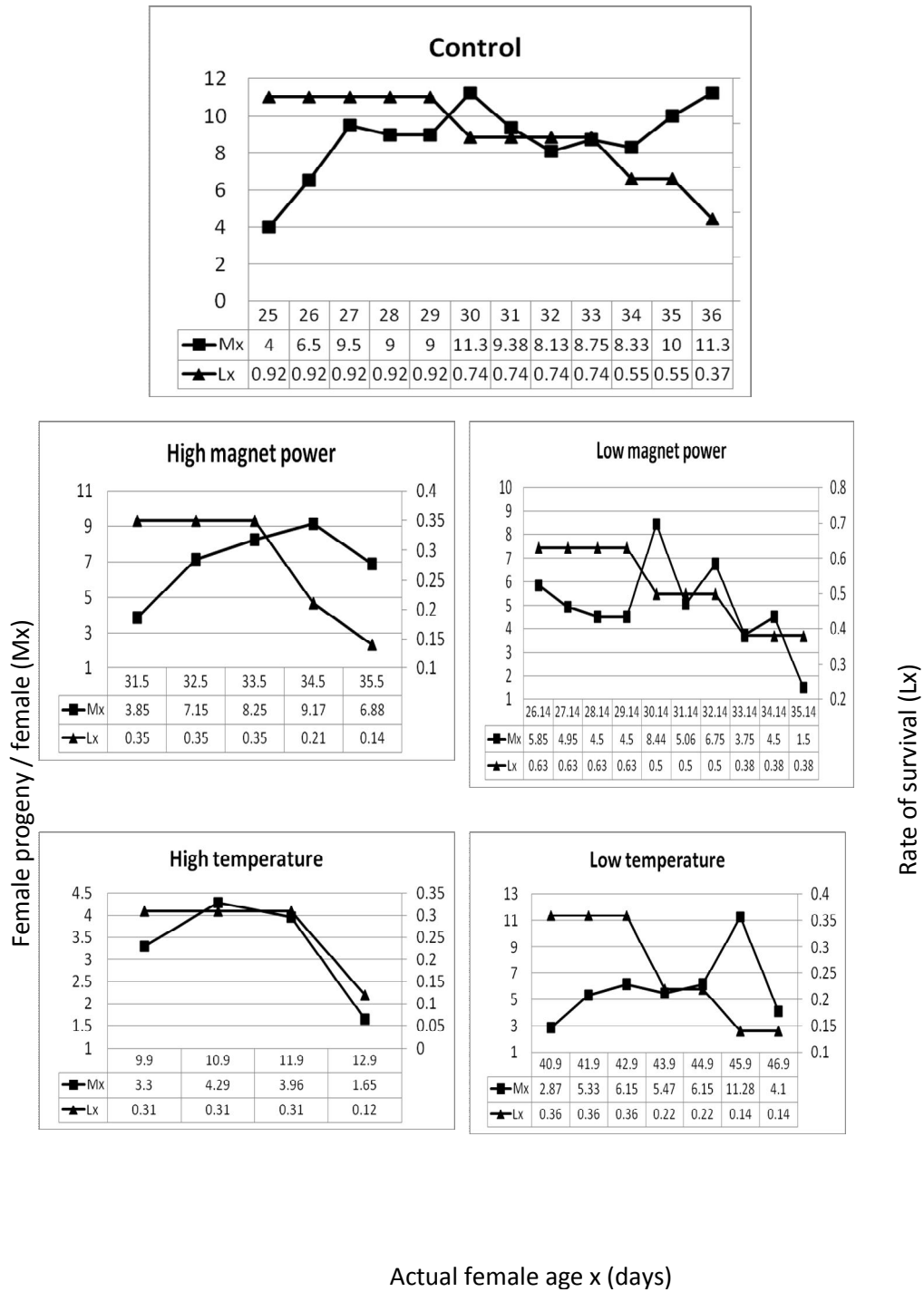











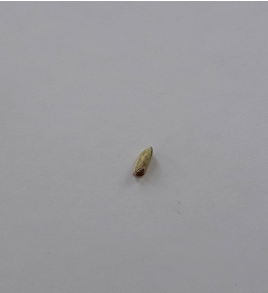

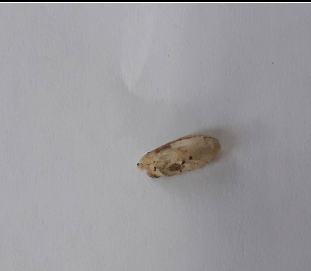



Fig. 3. Morphological distortions of *E. insulana* stages treated as adults (field strain) by magnetic field and temperatures.

Treatments	Larvae	Pupae	Adult moths
Untreated			
Temp. (30°C)			
Temp. (18°C)			
Magnet (28.6 mt)			
Magnet (2.21 mt)			

C. Morphological study.

Temperatures at two levels study had depressed morphological distortions on different stages of treated *E. insulana* as showed in figure (3). Dwarfing the larvae, pupae and moths as a result of adult moth treatment as described briefly in figure (3). The same distortions were found at two levels magnet treatments but less severe than temperature treatments as mentioned in the same figure. That distortions as a result of effect of treatments used on the most biochemical parameters of *E. insulana* as described following which is reflected on the morphological and also biological parameters.

D. Biochemical assays.

Total protein, free amino acids, total lipids, total carbohydrates, Alanine aminotransferase (ALT/GPT), Aspartate aminotransferase (AST/GOT) and phenoloxidase were assayed to determine the biochemical changes in treated adult moths with levels of magnetic and temperature degrees.

Table 4. Biochemical assays of *E. insulana* adults (field strain) treated with magnetic field and temperatures.

Biochemical aspects	Control	Magnetic levels		Temperature degrees		L.S.D _{0.05}
		MF1 (high)	MF2 (low)	High temp.	Low temp.	
Total protein (mg/g.b.wt)	17.57 ^d	9.60 ^b	12.60 ^c	6.9 ^a	11.9 ^c	2.925
Free-amino acid (µg D,L- alanine/g.b.wt)	502 ^d	225.7 ^b	325.7 ^c	132.2 ^a	275.81 ^b	60.87
Total lipid (mg/g.b.)	37.6 ^c	17.45 ^b	21.35 ^b	10.5 ^a	12.35 ^a	3.11
Total carbohydrate (mg/g.b.wt)	18.7 ^d	7.57 ^a	12.67 ^c	5.59 ^a	9.57 ^b	2.955
Alanine aminotransferase (ALT/GPT) (U x 10 ³ /g.b.wt)	1023.7 ^e	515 ^d	405 ^c	123.7 ^a	215 ^b	9.241
Aspartate aminotransferase (AST/GOT) (U x 10 ³ /g.b.wt)	1583 ^e	353.33 ^b	743.33 ^d	229.33 ^a	664 ^c	21.84
Phenoloxidase(O.D. units/g.b.wt)	5.90 ^b	2.81 ^a	2.81 ^a	6.81 ^b	3.1 ^a	1.521

MF1: high magnetic (28.6 mt) = (28.6 mt. in lower and 1.45 mt. in center jars).

MF2: low magnetic (2.21 mt) = (2.21 mt. in lower and 1.36 mt. in center jars).

1. Total protein.

Data presented in the Table (4) indicated that adults of *E. insulana* exposed to high magnetic field and temperatures had the highly reduction in the level of total soluble protein to reach 9.6 and 6.9 mg/g.b.wt, for high magnetic flux (28.6 mt) and high temperature (30 °C), respectively, in contrast, the larvae treated with low magnetic field (2.21 mt) and temperature (18 °C) increased the level of total soluble protein to reach 12.6 and 11.9 mg/g.b.wt compared to 17.57 mg/g.b.wt in the untreated.

Velide (2012) found that when exposure of aphid *Macrosiphum euphorbiae* (Thomas) to magnetic fields directly induced the transcription and biosynthesis of proteins, shortened the cell cycle, and accelerated cell division and development.

2. Free amino acids.

Table (4) cleared that free amino acids were sever decreasing in the adult female treated with high temperature (30°C) (132.2 µg D,L-alanine/g.b.wt), followed by in adult female exposed to high magnetic field at 28.6 mt (225.7 µg D,L-alanine/g.b.wt) as compared to untreated adults (502 µg D,L-alanine/g.b.wt); meanwhile, low temperature at 18 °C treatment was 275.8 µg D,L-alanine/g.b.wt and low magnetic flux at 2.21 mt treatment was 325.7 µg D,L-alanine/g.b.wt.

3. Total lipids.

On other hand, two magnetic field treatments reduced the total lipid content to 17.45 and 21.35 mg./gb.wt and the high reduction recorded with high and low temperatures (10.5 and 12.35 mg./gb.wt, respectively) in adults treated compared to 37.6 mg./gb.wt in control, (Table 4). Velide (2012) showed that lipid storage efficiency was lower in *Spodoptera exigua* (Hubner) at 18 than at 26 °C, and similar at 34 °C.

4. Total carbohydrates.

Table (4) recorded a high decrease in total carbohydrate (approximately to half time) when adults exposed to high magnetic field and temperatures, it estimated to 7.57 and 5.59 (mg./gb.wt/ larvae), respectively; while, a moderately decreased to 12.67 and 9.57 mg./gb.wt/ larvae, respectively when the adults exposed to low magnetic field and temperatures, respectively were happened compared to 18.7 mg./gb.wt/ larvae in control.

However, this reduction in the total protein, lipid and carbohydrate contents were necessary for energy, and fecundity of adults that may be reflect the decrease in activities, reduction in total eggs laid and decreasing in longevity adults. Velide (2012) found significant decrease in the carbohydrate and total protein content due to

degradation into amino acids as they contribute to energy in insect when compared with the control.

5. Transaminase enzymes (AST/GOT and ALT/GPT).

Data in Table (4) showed the transaminase enzymes activity in adults of *E. insulana* exposed to high and low magnetic field and temperatures. The reduction of GOT and GPT (approximately to half time) estimated by 515 and 405 U X 10³/g.b.wt when adults exposed to high and low magnetic field.

The transaminases of AST/GOT (Aspartate aminotransferase) and ALT/GPT (Alanine aminotransferase) have an important role in protein synthesis were seriously reduced at the temperature (approximately to three times) 123.67 and 215 when adults exposed to high and low temperatures, respectively.

Velide (2012) recorded that the transaminases as GOT and GPT reduced in the *philosamia ricini* larvae under cold stress. The activities of GPT and GOT present in haemolymph and fat body will be depressed in low temperatures).

6. Phenoloxidase.

Table (4) recorded the phenoloxidase of untreated adults that was 5.9 O.D.units/g.b.wt. The value was decreased in all the treatments except for high temperature treatment, the value was 6.81.units/g.b.wt. it had slightly increased than untreated.

Hussein, *et al.* (2018) investigate the effect of the magnetic field in storing seeds (wheat, corn and kidney) to control insects and mites infesting that crops and subjected to 9 months storing process in a suitable container. Storing technique depended on using a magnetic field among and between the grains and seeds under investigation. The obtained results showed low values in infested seeds compared to control especially after 6 and 9 months of storing. Also, it could be deduce that *Sitophilus granaries* () in kidney bean was more affected than the other pests.

Conclusion: The relationship among the developmental responses, biochemical of insects and the temperature or magnetic field is necessary to understand the ecology of insect life histories. The result recorded had the relationship between the high and low temperature or magnetic and reduction in fecundity, fertility and longevity for all adults used, due to reduction in total carbohydrate, protein, lipid that caused inhibition in metabolism process as well as the reduction in reproductive potentiality of SBW adults and all generations resulted. From all data can be concluded that the high temperature used with high magnetic tend to kill insect's cells by denaturing proteins, with destroyed the lipid and carbohydrates for energy, enzyme structures and properties, also, loss of water (dehydration) and they offer a rich potential for pest management strategies.

The magnetic field applications to control the pests in open fields need more scientific experiments to achieve the best applications.

Acknowledgements: The authors are greatly thanks to Dr. Abd El- khalik. M. Hussain, Chief Researcher, Plant Protection Research Institute, Agric. Res. Center for used magnetic during work.

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تأثير المجال المغناطيسى ودرجات الحرارة على القياسات البيولوجية وجداول الحياة والشكل الظاهري والصفات الكيميائية الحيوية فى دودة اللوز الشوكية

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تحت الظروف المعملية عرضت الأطوار البالغة (الفرشات) لدودة اللوز الشوكية إلى إثنين من المجالين المغناطيسين (٢٨,٦ و ٢,٢١ مللى تسلا) ومستويين من درجات الحرارة (٣٠ و ١٨ درجة مئوية) بهدف دراسة بعض الظواهر البيولوجية- جداول الحياة- التشوهات فى الشكل الخارجى للحشرة- القياسات الكيميائية الحيوية والتي حدثت لدودة اللوز الشوكية متأثرة بالمعاملات السابقة.

أظهرت النتائج أن الإناث التى عرضت للمعاملات السابقة زاد بها فترات ما قبل وما بعد وضع البيض بينما حدث العكس فى فترة وضع البيض. نفس الإتجاه حدث فى زيادة فى فترة حياة الطور البالغ للإناث والعكس حدث مع فترة حياة الطور البالغ للذكور. كما إنخفض عدد البيض/أنثى خاصة فى معاملة المجال المغناطيسى العالى ودرجة الحرارة العالية مثلما حدث تماما فى النسبة المئوية للخصوبة. تأثر أيضا الجيل الأول الناتج من الطور البالغ المعرض للمعاملات السابقة حيث زادت فترتى حياة الطورين اليرقى والعذرى كما زادت أيضا النسبة المئوية للخفض والموت للطورين اليرقى والعذرى كما زادت فترة ما قبل وضع البيض للفرشات الناتجة فى الجيل الأول والتي عرض أبائها إلى المعاملات المذكورة.

أظهرت قياسات جداول الحياة لدودة اللوز الشوكية خفضا فى معظم المعاملات لعدد الإناث الناتجة/أنثى (Mx) وفترة البقاء (Lx) - معدل التناسل (Ro) - القدرة التناسلية الموروثة (rm) - معدل الزيادة النهائى (em) - النسبة الجنسية وذلك فى معظم المعاملات كما حدث العكس بزيادة فترة الجيل (T) والفترة التى يتضاعف فيها الجيل (DT) فى معظم المعاملات وذلك مقارنة بالكونترول.

أوضحت التقديرات الكيميائية الحيوية لدودة اللوز الشوكية خفضا فى البروتين الكلى والأحماض الأمينية والليبيدات الكلية والكربوهيدرات الكلية وكذلك إنزيمات ألانين أمينوترانسفيريز ((GPT), (ALT)) و أسبارتات أمينوترانسفيريز ((GOT), (AST)) والفينول أوكسيداز التى إنعكست على حيوية الآفة مما أدى إلى ظهور التشوهات الحادة فى الشكل الظاهري فى جميع الأعمار وخاصة الناتجة من معاملة درجة الحرارة العالية ٣٠ درجة مئوية.

مما سبق إتضح أن معاملات المجال المغناطيسى العالى ودرجة الحرارة العالية كانوا أكثر تأثيرا على دودة اللوز الشوكية وذلك مقارنة بمعاملة المجال المغناطيسى المنخفض ودرجة الحرارة المنخفضة.

