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Study the Effect of Times Exposure to Magnetic Power on Fertility and Fecundity of the Pink Bollworm, *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidea) Adult under Laboratory Conditions

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ABSTRACT

The adult stage of pink bollworm, *Pectinophora gossypiella* (Saunders) laboratory strain was exposed to magnetic fields (180 mt) at three times (12, 6 and 4 min) to study the effect of exposure time on mortality, morphological, oviposition, total eggs laid and fecundity and fertility comparison to the control under laboratory conditions 26±1° C and 75±5 RH. The results showed that the mortality percent of treated females and males during mating was high increased when exposed to magnetic power (180 mlt) for 12 min (39% mortality) followed by 22 and 13% mortality when adult exposed to 6 and 4 min, respectively. While, the female magnetized sexed with untreated male the percent mortality decreased to 3-4 times compare to anther treatment (9, 6 and 2%, respectively). Data obtained recorded that decreasd in oviposition period in the most treatments time; vice versa was happened with the adult female longevity that increased in the most treatments and contrary in male adult longevity. Eggs laying of treated adult female had significant reduction especially in magnetic field with exposed to12 and 6 minutes as well as hatchability percentages.

Keyword: magnetic, times, *Pectinophora gossypiella***,** and survived, fecundity and longevity

INTRODUCTION

The adult moth of pink bollworm, *Pectinophora gossypiella* (Saunders), (PBW), (Lepidoptera: Gelechiidea), had under the soil or in soil cracks during the day and become active for mating and laying eggs at the night on all parts of cotton plant especially flowers, squares and bolls. Eggs hatch from 3-4 days; the larvae considerable the major stage attack the cotton fields. It causes serious damage in cotton bolls and great loss as in both quality and quantity of cotton yield (Noble, 1969).

Magnetic fields (MF) has been increasingly important; it used in research laboratories studied continually become growing by many authors since 1959 until 2018, because it considerable one from many important environmental factors, has significant influence on living some organisms. It can make changes in many biological systems.

The number of experimental including a wide range from insects; such as used the MF magnetic field with *Drosophila* caused increased the percent mortality and decreased the oviposition (Ramirez *et al.,* 1983), also, (Chun, *et. al. 2014*) recorded that the adults of *Euproctis pseudoconspersa* (EP), highly affected when it were exposed to electromagnetic field.Walters and Carstensen (1987) on fecundity and development in *Drosophila*, behavior and metabolism also, exposed the pupal stage of *P. gossypiella* to magnetic power (28mlt) increased the mortality and reduction the percent of adult emergence (Said *et al*. 2017), MF high effected on survivor, longevity, viability and fertility of *Earias insulana* (Kandil *et al.,* 2018) also, (Pan *et al.,* 2004), development and viability (Biljana *et al*., 2001), longevity and fecundity of *P. gossypiella* (Said *et al*. 2017),

The objective of this work was to study effect of exposed the adult stage of *P. gossypiella* to different durations of times (12, 6 and 4 minutes) of magnetic power on the reproductive female and behavior of adult male and female.

MATERIALS AND METHODS

Insect used:

The adults' stage of the pink bollworm, *P. gossypiella* (PBW) used:

The laboratory strain of adults stage; freshly emerged moths of *P. gossypiella* was fed on a piece of cotton wool previously soaked in 20% sugar solution was suspended to be renewed each 48 hr for moths' nutrition described by Rashad and Ammar (1985) under the laboratory conditions at 26±1°C and 75±5 RH at Bollworms Research Department, Plant Protection Research Institute, Agriculture Research Center.

Adjusting and creating the magnetic and exposure:

The apparatus of magnetic field consists of two components: Inside the first one components were eight magnetic pieces ; each piece measured, 30mlli- tesla power were arranged inside a row in an attractive position. Another 8 magnetic pieces similar arranged inside a row (number 8 magnetic pieces and power) represented the second component, the two rows were put together by parrarels (with 2 cm distance between) and in repulsion positionas (shown in Figure, 1), which allows the magnetic power to 180 mlt. This apparatus was arranged and measured in faculty of Engineering, Menofiya University using mille-tesla meteras (shown in figure, 2). Insects (adults' stages) exposed to the magnetic field power (180 mil- tesla) to different durations of times (12, 6 and 4 minutes) as indicated.

Fig, 1. Apparatus consists of 2 rows Inside each row 8 magnetic pieces

Fig, 2. Apparatus of Mille Tesla meter

Fig, 3. Exposed *P. gossypiella* adults Magnetic power

Effect of exposed time of magnetic power on *P. gossypiella* adults*:*

The freshly emerged moths of PBW (one day old) resulted from the laboratory strain were divided to four groups each group 45 pairs, each group was divided to three sub groups each one 15 pairs and replicate three times each replicate (5♀♀ x 5♂♂);

Each group transferred to glass tube (1.5cm x 15cm) for exposed to magnetic field (magnetization) for (different durations of times) three times (12, 6 and 4 minutes) each females and/ or males exposed to high magnetic power 180 mill-tesla

The 1st group: female and male treated (female and male magnetization).

The female and male were exposed to magnetic field 180 mlt for 12 min., anther group exposed to 6 min. and anther group exposed to magnetic power for 4 min.

The 2nd group:the female treated (female magnetization)

The only females, exposed to magnetic field 180 mlt for 12 min., anther females group exposed to MF for 6 min. and anther females group exposed to magnetic power for 4 min**.**

After exposed the female to magnetic (female magnetization) at 12 or 6 or 4 min were sexed with untreated male (♀♀magnetization **x**♂♂normal)

The 3rd group: the male treated (male magnetization).

In this group; the only males, exposed to magnetic power 180 mlt for 12 min, anther males group exposed to 6 min and anther males group exposed to magnetic power for 4 min.

After exposed the male to magnetic (male magnetization) for three times were sexed with female untreated (♂♂magnetization **x**♀♀normal)

The 4th group: untreated female sexed with untreated male (zero magnetic) as a control.

After exposed the different groups to magnetic; the moths, transferred to chimney glass cage (5 pairs /cage). It was replicated three times. The moths were fed on a piece of cotton wool previously soaked in 20% sugar solution was suspended to be renewed each 48 hr for moths' nutrition.

All cages were examined daily; to investigate the pre-ovipostion, ovipostion and post-ovipostion periods, observed the survived of females and males (longevity); also, number of eggs laid daily for each treatment were estimated. The deposited eggs from each treatment were collected daily and maintained at 26±1° C and 75±5 RH to estimate the hatchability percentage

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:

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

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

Reduction %= % living in check-% living in treatment/ check X100 (Abbott, 1925).

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

RESULTS AND DISCUSSION

Effect of exposure time to magnetic power on *P. gossypiella* adults:

Adult moths of *P. gossypiella* were exposed to magnetic power (180 mt); in addition, exposed to (different durations of times) three times (12, 6 & 4 min.) to study the effect of different exposed times on some biological aspects as following:

Adult mortality and malformed percent:

Data presented in Table (1) indicated that the percentage of adult mortality during mating female with male exposure to magnetic power for different durations of times (three times) 12, 6, 4 min, estimated by 39, 22 and 13 %, respectively, while, it high decreased when treated female (female magnetization) was mated with untreated male to 9, 6 and 2 % mortality, respectively, in contrast, when exposed males to magnetic (female magnetization) and sexed with untreated females, the mortality percentages were increased to 21, 12 and 4 % (during the mating) after exposed the males to three times (12,6 and 4 minutes, respectively), (Fig., 5&6) showed that the dead during the mating (cabling ♀ with ♂), and malformation of copulate apparatus in treated adult male, compared to control (the male dead without any malformed (Fig, 4).

The results of our study confirmed with (Juan, 2012) recorded that the negative effect on *Sitobion avenae* (Fabricius); on survival rate, under the exposure of 0.176 mt for 30 min and increased the mortality when exposed to SMF (0.065mt) for 60min. Also, (Martin *et al.,* 1988 and Tian and Lu*.,* 2009) showed that a static magnetic field reduced the flying activity of bees and increased the mortality more than 60% in all treatments. Walker and Bitterman (1985) found a significant negative effect of MF on survival rate and increased the percent mortality of honeybees treatment, also, (Tian *et. al.* 2015) recorded that when exposed of *Nyctalus plancyi* to magnetic field (10 μT) cussed high effect on flight behavior and mortality.

Table 1. Percent of adult mortality and malformed

Types of adult exposed	% Of mortality and malformed when adults exposed		
	12 minutes	6 minutes	2 minutes
♀♀treated x ♂♂treated	39.0	22.0	13.1
♀♀treated x ♂untreated	9.3	6.2	2.3
♀♀untreated x ♂♂treated	21.0	12.0	4.0
(♀♀ x♂♂)untreated	1.0	1.0	1.0
LSD	1.240	1.021.	0.854

Fig. 4. Male normal

Fig.5. Male malformed (malformation of copulatory apparatus in treated adult male)

Fig. 6. Died female with male during mating(cabling ♀ with ♂)

Adult longevity:

As clearly shown from the data in Table (2) that females and male longevity highly affected when exposed to magnetic field (180mlt) for different durations of times (three times) 12, 6, 4 minutes.

When mating female (♀♀) magnetization with male (♂♂) magnetization; Data obtained in Table (2) showed that elongated the adult female longevity that was 18.3, 21.2 and17.0 days / female exposed to magnetization for 12, 6 and 4 minutes, respectively, compared with 16.3 days /female in control on the other, when matted female magnetization with male un exposure; the adult female longevity prolonged to 26.3, 22 and 17.3 days / female magnetization at 12, 6, and 4min., respectively. But in case of magnetic male only (♂ magnetization x with ♀ un exposure) the longevity female decreased (from 0.3 to 2 days) to 13.4, 16.0 and 15.0 days / female no-magnetization at three times, respectively, compared with 16.3days /female in control (zero magnetic).

At the same times, when exposed male to magnetic power (180 mlt) for the same periods of time exposed (12, 6 and 4 minutes) and sexed with females treated (female magnetization) or female untreated (female un exposure), the data in Table (2) recorded that no different between longevity estimated, and it reduced to 9.6 &9 days/ male exposed to 12 min., 9.0 & 10.0 days/ male exposed to 6 min and 11.3 & 11.3 days/ male exposed to 4 min compared with 13.0 days/ male in control. The obtained data are in agreement with many authors studied that the different magnetic powers against Lepidopterous insects, e.g., *P. gossypiella*, and Said *et. al*., (2017) and *Earias insulana* Kandil *et al*., (2018) they recorded the high increased in longevity females exposed to MF, on contrast the decreased in longevity males.

Table 2. Times observed (in days) and mortality for *P. gossypiella* adults exposed to magnetic power.

Types adult exposed	Times exposed					
	12 minutes		6 minutes		4 minutes	
	Observation times in days (longevity)					
	Female	Male	Female	Male	Female	Male
♀♀treated x* ♂♂treated	18.3 (20-31)	9.6 (10-20)	21.2 (15-29)	9.0 (6-19)	17.0 (14-21)	11.3 (7-13)
♀♀treated x* ♂untreated	26.3 (17-34)	15.3 (12-18)	22.0 (18- 29)	11.0 (7-13)	17.3 (15-26)	12.0 (8-16)
♀♀untreated x* ♂♂treated	13.4 (10-23)	9.0 (7-17)	16.0 (10-20)	10.0 (9-18)	15.0 (8-19)	11.3 (6-13)
untreated (♀♀ x♂♂)	16.3 (12- 21)	13.0 (10- 19)	16.3 (12- 21)	13.0 (10- 19)	16.3 (12- 21)	13.0 (10-19)

x* mating with

Oviposition period and total eggs laid (Reproductive potential):

Data recorded in Table (3) revealed that the exposed females and/ or males of *P. gossypiella* to magnetic power (180mlt) for different times high significant affected on the oviposition period and results showed a significant reduction in the number of deposited eggs per each treated female of *P. gossypiella*

Table 3. Ovipositiol period and total eggs laid by *P. gossypiella* adults magnetization exposed to three times.

Types adult exposed	Times in days when adults exposed					
	12 minutes		6 minutes		2 minutes	
	Oviposition	Total eggs laid	Oviposition	Total eggs laid	Oviposition	Total eggs laid
♀♀treated x ♂♂treated	9.6 ±0.13	122 ±3.1	10.0 ±0.3	132.0 ±4.2	11.6 ±0.5	165.0 ±3.1
♀♀treated x ♂untreated	14.1 ±1.6	127 ±5.1	13.6 ±0.4	162.0 ±6.5	12.9 ±0.3	187.0 ±4.6
♀♀untreated x♂♂treated	9.0 ±1.3	159 ±3.6	9.6 ±0.8	171.0 ±3.9	10.3 ±0.7	191.0 ±6.1
(♀♀ x♂♂) untreated	11.3 ±1.13	254.6 ±6.4	11.3 ±1.13	254.6 ±6.4	11.3 ±1.13	254.6 ±6.4
LSD	0.16	1.893	0.28	6.55	0.0561	5.74

The respective, mating female with male after exposed to power magnetic (female with male magnetizations) for12, 6 and 4 min decreased the oviposition period to 9.6, 10.0 and 11.0 days, respectively. At the same times the female laid 122, 132, and 165 eggs/ magnetization female, respectively, on the other hand, when mating female treated (female magnetization) with male untreated (female magnetization x male untreated) the oviposition period increased to 14.1, 13.6 and 12.9 days when females exposed to magnetic for 12, 6 and 4 min, respectively, during these period the female laid 127.0, 162.0 and 187.0 eggs/ female magnetization, respectively. While, in case of mating female untreated with male treated (♀♀untreated x ♂ magnetization) the oviposition period decreased to 9.0, 9.6 and 10.3 days when male only

exposed to magnetic for 12, 6 and 4 min, respectively, at the same time, the female laid 159, 171 and 191eggs/ female, respectively, compared to 11.3 days/ female (oviposition period) and 254.6 eggs/ female (total egg laid) in control.

From this data can be indicated that when the both adults female and/or male exposed to high power magnetic (180mlt), generally lead to the reproductive failure (approximately to half time) in females, it may be because the male exposed to power magnetic lead to, did not mate or effectively transfer sperm to spermatheca of the female, also, increased the percent mortality during mating female with male. On the other hand, the females exposed to power (180 mlt - MF) becomes resting activity had reduced eggs lying and eggs viability. The obtained data are in agreement with many authors studied the effect of different magnetic powers on different insects, e.g., Ramirez et al. (1983) found that 1 mT reduced the oviposition rate and increased the immature mortality rate, Pan (1996) reported the biological effects of a 7 T MFs on fertility of *E. kuehniella*, how recorded The hatching of the eggs in the 7 T field was delayed and hatching rate was high decreased and (Juan, 2012) showed that the fecundity of *Sitobion avenae* (Fabricius) were significantly affected by SMF after exposure to SMF; Starick, *et al.* (2005) demonstrated that the different in level magnetic had high effected on the fecundity and percent of hatchability of *Rhyzopertha dominica* (Fabricius).

Fertility (%hatchability) and Reduction:

Statistical analysis of data in Table (4) demonstrated that highly significant differences between the percent of hatchability of eggs laid (fertility) by adults females after exposed to magnetic power for different periods of time exposed and the control. The percent of hatchability of deposited eggs by females treated mated with treated male (♀♀and ♂♂ magnetization) for three times (12, 6 and 4min.) were 39 ,53 and 67 eggs/♀♀with ♂♂ magnetization and increased gradually to 53, 59 and 63 eggs/(♀♀ magnetization only mating with male no magnetization) and high increased to 67, 71 and 80 %female when the ♀♀normal sexed with♂♂ magnetization|) compared to 96% eggs/ female in control.

At the same trend, the treatment females(female magnetization) and exposed to different times (12, 6, and 4) caused high reduction in percentage of hatchability (59.37, 44.7 and 30.2 % reduction) followed by females magnetization sexed with male no magnetization (48.95, 38.5 and 26.0 % reduction) (Table) , similar results were obtained by Pandır , *et. al.* (2013) recorded that when exposing *E. kuehniella* adults to increasing levels of MFs influenced their daily egg production with reduction in progeny production, (Walters and Carstensen, 1987 and Tian and Lu, 2009) recorded the high reduction in fecundity and firtility of Drosophila when exposed to magnetic fields. Walker and Bitterman, (1985) found a significant negative effect on fecundity and hatchability present of Drosophila.

Table 4. the reduction in reproductive potential of *P .gossypiella* adults when exposed to magnetic power for different times.

Types adult exposed	Times adults exposed					
	12 minutes		6 minutes		2 minutes	
	%of hatchability eggs	%of reduction	%of hatchability eggs	%of reduction	%of hatchability eggs	%of reduction
♀♀treated x ♂treated	39	59.37	53	44.7	67	30.2
♀♀treated x untreated	49	48.95	59	38.5	71	26.0
♀♀untreated x treated	55	42.7	64	33.3	80	16.6
(♀♀x♂♂) untreated	96	-------	96	------	96	-------
LSD	2.152	--	3.621		5.211	

CONCLUSION

The present data indicated that there was a significant negative effect on the reproduction process in females magnetization and sometimes lead to the failure in eggs laid or high reduction in fertility when the adults female and/or male (magnetization) were exposed to the high power magnetic (180 mlt) for 12 and 6 minutes; because it due to resting (not activity) female and male, failure mating, increased the mortality during the mating for the adult magnetization.

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دراسه تاثير مده تعريض القوي المغناطيسبه علي الخصوبه لفراشات دوده اللوز القرنفليه

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تم استخدام تقنية المجال المغناطيسي الثابت لدراسة مدي تغير بعض القياسات البيولوجية لدودة اللوز القرنفليه(اناث و ذكور تحت الدراسه). و قد تم استخدام مستوي من المجال المغناطيسي الثابت بقوة (180 مللى تسلا)) علي الذكور و الاناث و تعريضهم للمدد الزمنية الثلاثه المختلفه (4, 6 و12) دقيقةعلي النحو التالي. 1- قد تم تعريض الاناث و الذكور معا للمجال المغناطيسي(اناث و ذكور ممغطه) للثلاث فترات مختلفة 12و 6و 4 2- تم تعريض الاناث فقط للمجال المغناطيسي للثلاث فترات مختلفة و تزاوجها لذكور غير معامله(اناث ممغنطه مع ذكور غير ممغطه) 3- تم تعريض الذكور للمجال المغناطيسي للثلاث فترات المختلفة و تزاوجها باناث غير معامله (اناث غير ممغنطه مع ذكور ممغطه) -4-تم استخدام ذكور و اناث غير معامله ككنترول اظهرت النتائج تاثيرا مباشرا على نسب الموت لكلا الفرشاتت المعاملة حيث سببت ارتفاع في نسب الموت لكل من ذكور و اناث دودة اللوز القرنفلية ارتفعت بزيادة المدة الزمنية للتعريض 12 و 6 دقيقه لقوة المجال المغناطيسى. كما سببت المعاملات اطالة معنويه فى فترة حياة الاناث ضعف الذكور بلغت اقصاها عند التعرض لقوة المجال المغناطيسى لمدة 12 دقيقة ثم 6 دقيقة بينما لم يظهر التعرض لمدة 2 دقيقة اي تاثير قوي مقارنتا بالكنترول. كما أوضحت النتائج تاثيرا على ارتفعت نسبة التشوه فى الفراش عند عمليه التزاوج مقارنة بالكنترول، كما ان التعرض لقوة المجال المغناطيسى ا180 مل سل لمدة 12 دقيقةو 6 دقائق ادي الي تاثير سلبي علي مجموع البيض الموضوع كما امتد التأثير أيضا ليشمل نسب الفقس فى البيض الناتج حيث ادت المعاملات المذكورة الى خفض عالي فى تلك النسب الموضوعه وكان التاثير اكثر وضوحا عند التعرض الاناث سواء تزاوجها مع ذكور معامله او ذكور غير معامله لقوة المجال المغناطيسى لمدة 12 دقيقة و 6 دقائق مما سبق يتضح التاثير المباشر و الممتد لاختلاف المدة الزمنية بعد التعريض للمجال المغناطيسى على طور الفراش الكامل سواء كان اناث او ذكور لدودة اللوز القرنفلية و مدي تاثيرها كميه البيض الموضوع و الخفض في نسب الفقس للبيض فكان اكثرهم خفضا للبيض الموضوع و نسب الفقس للفرش المعرض لمده 12 دقيقة ويليه المعرض لمده 6 دقائق مما يشير الي امكانيه استخدام المجال المغناطيسي في الحقل كنوع من اساليب المكافحه (نوع من التعقيم الجزئي للذكور مع قله النشاط لجزئي للذكور و الاناث)