Minufiya J. Agric. Res. Vol.39 No. 1(2): 327 - 338 (2014) "http://www.mujar.net"

POTENTIAL BENEFITS FOR UTILIZATION MAGNETISM IN PLANT PROTECTION

A.M. Hussein, M.A. Eweis , Salwa S.M. Abdel- Samad and A.E. Hatem
Plant Protection Research Institute, Agriculture Research Center , Dokki , Cairo , Egypt

(Received : Nov. 23 , 2013)

ABSTRACT: *The current research aimed to investigate changes in the state of egg hatching of four economic insects: Sitotroga ceralella, Trichogramma evanescens, Spodoptera littroralis and spodoptera exigua. A completely randomized experiment with three replicates was designed. Similar groups of eggs of the above mentioned insects were prepared and exposed to the magnetic field resulted from 1,5 and 11 magnet units, (140- 160 gauss resulted from each) control was left without treatment. Along 10 days the daily observations included: hatchability percentage, developing and emergency, living and /or death of the larvae under the three magnetic field treatments. Results showed that there was a linear negative relationship between the force of the magnetic field and the hatchability percentage of the eggs exposed in. Sitotraga sp. hatching eggs were decreased from 90%(in the control) to 22% in the magnetic field with (11megnet unit) Also, Trichogramma sp decreased from 82.31% to 47.06% while egg hatching of Spodoptera littroralis was decreased from 95.20% to 56.80, finally S.exigua decreased from 90% to 50.86%.*

Many investigations have to be done in using magnetism and magnetic field to minimize the population of harmful insects . Also , magnetism may delay egg development of Sitotroga sp. to be more suitable for Trichogramma parasite production programmes .

Key words: *Magnetic field, Magnetism, Pest control, Insect egg hatchability.*

INTRODUCTION

The correct strategy of integrated pest management (IPM) have to include many practices, involving different kinds of pest control methods aiming to crop increase.

In spite of all control efforts, pests annually destroy about 35% of all crops broad used worldwide . (Win 2010)

The discovery of new safe and effective pseticides is one of the means of providing eco-friendly agricultural agents for modern crop protection (OU Jan Jan *et al* 2012)

The use of physical method for insect control in organic farms represents important measures in biosecurity system (Cioban *et. al*.2013).

The physical methods for insect control include : irradiation with gamma rays, (Hussein *et. al.* 1999), using UV Rays (Cia *et al.* 2010), temperature (Reguzzi *et. al,* 2011), fumigation (Ciesla *et. al,* 2010), drying and cooling (Beckett 2010), high voltage static electricity (Zhu lin *et al.* 2011), vacuum (Kucerova *et. al,* 2013) and normal sieving (Shrikant and Ramaraju, 2012).

Magnetism and using the magnetic field seems to be promising physical method in insect control. Many workers stated the Relationship between the power in magnet lines and behavior of some insects.

Posfai and Dunin (2009)stated that ferrimagnetic nanocrystals are present in usually every organism, they added that the advanced techniques revealed the complex interplay between the physical and magnetic properties and biological functions of the ferrimagnetic nanocrystals in bacteria.

Wijenberg *et.al.,* (2013) investigated electromagnetic field on attraction some insects e.g. German cockroaches to offer non-toxic alternatives to pesticides.

Understanding the biophysical basis of animal magnete – reception has been one of the greatest challenges in sensory biology (Gegear *et al* 2010).

Maeda *et. al.,*(2008) stated that, approximately 50 species, including mammals, birds, reptiles, amphibians, fish, crustaceans and insects are known to use the earth's magnetic field for orientation and navigation.

Paz *et. al.,* (2012) studied the spatial orientation of some social insects e.g. bees, termites and ants during their search for food and transposting it, In their research they discussed it based on some geomagnetic field mechanism in these insects.

Gao and Zhai (2010) reviewed the progress insect spatial orientation mechanism depending on variety of information including sun compass as well as magnetic, celestial compass and wind and land marks.

Maeda *et al.* (2008) stated that the effect of magnetic forces on insects depend on a proposal based on magnetically sensitive free radical reactions.

Giraldo *et al.* (2013) investigated and discussed the response to magnetic effect in insects as a result of presence and /or absence of some ferromagnetic materials in bodies of some insects e.g. Apis *mellifera* (honey bees), and *R.prolixus*, they used VSM magnetometer as a sensitive technique for detecting ferromagnetic materials in the insect tissues.

Gonil and Sajonsang (2012) referred to a type of relationship between effect of magnetion and chitin in the cuticle of insect body.

Xie chunlan *et. al.,* (2011) explained the geomagnetic orientation of some insects e.g. the brown plant-hopper *N.lugens* based on presence of magnetic material in the abdomen of *N.lugens*, in the meantime these were no presence of these materials in the cephalothorax of adults, referring to, the existence of magnetic materials in this body part provides physical basis for its geomagnetic orientation during the long distance migration.

Cao *et al.* (2010) reported that magnetic field had significant influence on the body color of locusts, that may be useful for developing insects.

Vacha and Drstkova (2008) suggested that insect antennae play a certain role in magnetoreception.

MATERIALS AND METHODS

As the eggs of pests represent the weakest point along the life cycle of these pests,this lab. experiment aimed to investigate the effect of the magnetic field on the hatchability of four insect eggs.i.e. : *Sitotroga ceralella*, (Gelechiidae: Lepidoptera), *Trichogramma evanescens* (Trichogramatidae: Hymenoptera), *Spodoptera littoralis* and *Spodoptesa* exigua (Noctuidae:,Lepidoptera). According to the nature of rearing each insect a certain and limited number of eggs was prepared for starting the experiment (Tables 1-4) , in addition to a similar appropriate rearing boxes. In respect of *Sitotroga sp* four rearng boxes were prepared, the first was left without any treatment as a control treatment (0), while the other 3 boxes were exposed to magnetic field resulted from 1, 5 and 11 similar magnetic unit (each measure 14-16 mt , mili tesla). These unite were fixed on the edge of rearing boxes by the way to ensure the eggs position and /or the hatched larvae in the focus (or the center) of the magnetic field 140-160 gauss equal (14-16ml tesla) resulted from 1 unit. The rearing boxes were kept in Laboratory under 25±2 C^0 and relative humidity (RH) 75%, and kept with 1 meter as a distance between each other. Then, treatments were subjected to daily examination recording all available data e.g. number of newly hatched or emerged larvae, hatchability percentage, the hatching period and the period before death. As for *Sitotroga* sp and *Trichagramma* sp, they were left without feeding along the observation period (10 days) while, the hatched larvae of both *Spodoptera latorallis* and *S. exigua* were fed on fresh leaves of castor bean *Ricinus communis*. Data were classified and analysed then tabulated to compare with control treatment.

RESULTS AND DISCUSSION

Results in Table (1) explains egg development and hatchability percentage of *Sitotroga ceralella*, during the experiment period under the 4 treatment of magnetic

Table 1

field strength, which were resulted from supporting with 0,1,5 and 11 magnetic units. Data show that egg hatchability percentage recorded 90, 87, 70 and 22% in the 4 pre-mentioned treatments respectively. Results also reveal that increasing the magnetic field (MF) strength led to decrease in egg hatchability in a linear relationship pattern, in addition the hatched larvae lived shorter period under the strongest (MF) treatment, as the period before death recorded 9,8,9 and 6 days respectively.

Results in Table (2) indicate the egg development and hatchability percentage followed by individual emergency of *Trichogramma* sp. Under the 4 treatments 0.1.5 and 11 magnetic units. The same trend of decreasing egg hatchability percentage with increasing (MF) strength was confirmed, as these figures recorded 95.4, 86.2, 68.2 and 56.8% under the 4 above – mentioned treatments respectively. Also, all individuals lived shorter periods (8days) under the (MF) with 5 and 11 units against (9days) under 0 and 1 unit .

Table (3) and Fig (1) shows the egg hatchability percentages of *Spodoptera littoralis* under control treatment compared with those under magnetic field (MF) resulted from 1,5 and 11 magnet unit. Data show that hatchability percentages gradually decreased in a linear negative relationship as it was recorded 72.71%, 67.24% and 50.86% under the above mentioned (MF), compared with 90% hatchability in the egg group without any magnetic field (control). Hatching period considerably decreased under the magnetic field with 5,11 units, as it was recorded 4 and 3 days respectively, where it was 6 days under both treatments of 0,1 units.

Results in Table (4) and Fig (1) include egg hatchability percentages of *Spodoptera exigua* under the magnetic field resulted from 0,1,5 and 11 magnet units. The same trend of the previous results was confirmed as it recorded 82.31%,80%, 72.22% and 47.06% respectively. Also hatching period ranged between 3 and 5 days (MF) with 0 and 1 unit, while it was only 3 days under (MF) of 5 and 11 units.

Table (5-a) reflect the general trend of the linear negative relationship between egg hatchability and intensity of MF resulted from the magnet units e.g. 1,.5 and 11 units compared with the control egg group which was kept out of magnetic influence.

Results in Table (5-b) show the difference between egg hatchability under MF with 11 magnet units compared with control (without MF). Data shows that *Sitotroga ceralella* eggs was the highest affected and most sensitive as the comparison between hatchability percentage in control (without MF) recorded 90%, while it was 22 (with MF)resulted from 11 magnet units, that means difference – 68%. This difference value followed by – 39.14% for *Spodoptera littoralis*, 35.25% for *S.exigua* and 38.4% for *Trichogramma* emergency percentage.

Nabeel K. Al Ani (2012), in his studies on the effect of magnetic field on mites concluded that MF reduced the number of mature mites, while it increased the number of eggs. In this study it seems that magnetic field led to disturbance in egg cells components as a result of the high temperature resulted from the magnetic power lines in the magnetic field, this disturbance may led to confirm the opinion of (Rockrtein 1974) that we agree with, as he stated that increase temperature may cause protein denaturalized and liquidize of fats and phospholipids in the cell.

Gonet *et. al.,* (2009) studied the effect of low frequency magnetic fields on the oviposition of *Dorosophila melanogaster* over 3 generations, their results showed that, the magnetic field weakened the oviposition of the tested insects.

Table 2

Table 3

Fig 1

Table 4

Table 5 a

Table (5-b) : The Negative influence on egg hatchability under (MF) for the insects under investigation in comparison with control

insects eggs :	Hatchability Percentage		Decrease in egg hatching
	Without MF	With MF (11 units)	
Sitotroga ceralella	90	22	-68%
Trichograma evanescens	95.2	56.8	38.4%
Spodoptera littoralis	90	50.86	-39.14%
Spodoptera exigua	82.31	47.06	-35.25%

REFERENCES

Beckett S. J. (2010). Protecting and disinfesting stored products by drying and cooling, and disinfesting stored products during handling by mechanical treatments. Julius-Kuhn-Archiv, (425):219-228.

Cao Chengquan, Zhang Helun, Chen Hailin and Huang Cheng Jun (2010) Influence of magnetic field on body colour of *Locusta migratoria* manilensis, Chinese Bulletin of Entomology, 47(2):340-342.

Cioban, G., Tibru, I Sala, C Morar and A Nichita (2013). Establishing an effective program operation of a fly killer device in controlling of insect from organic farms, Lucrari Stiintifice- Universitatea de Stiinte Agricole a Banatului Timisoara, Medicina Veterinara, 46(1):28-32.

Ciesla, Y., P. Ducom and J. Fritsch (2010). Methyl Iodide: a potential fumigant for post-harvest and quarantine disinfestation. Julius-Kuhn-Archiv, (425):358.

Cia, P., E. A. Benato and S.F. Pascholati (2010). Use of irradiation in postharvest disease management: Problems and solutions, Stewart Postharvest Review, 6(4): article 3.34.

Gonil, P. and W. Sajomsang (2012). Application of magnetic resonance spectroscopy to chitin from insect cuticles. International Journal of Biological Macromolecules, 51(4):514-522.

Gonet, B., D.I. Kosik-Bogacka and W. Kuzna-Grygiel (2009). Effects of extremely low-frequency magnetic fields on the oviposition of *Drosophila melanogaster* over three generations, Bioelectromagnetics, 30(8):687-689.

Giraldo, D., C. Hernandez and J. Molina (2013). In search of magnetosensitivity and ferromagnetic particles in *Rhodnius prolixus:* behavioral studies and vibrating sample magnetometry. Journal of Insect Physiology, 59(3):345-350.

Gegear, Robert J., Foley, Lauren E, Casselman, Amy Report and M. Steven (2010). Animal cryptochromes mediate magnetoreception by an unconventional photochemical mechanism.Nature, 463(7282):804-807.

Geo Yuebo and Zhai Baoping (2010). Progress in the mechanisms of insect orientation, Chinese Bulletin of Entomology, 47(6):1055-1065.

Hussein, A.M., S.A. Fatma and S.M. Soliman (1999). Utilization of gamma rays to control the two spotted spider mite *Tetranychus urticae* Koch, Minufiya J.Agric. Res. Vol.24 No. 4 1289-1300.

Kucerova, Z., K. Kyhos, R. Aulicky and V. Stejskal (2013). Low-pressure treatment to control food-infesting pests (*Tribolium castaneum, Sitophilus granaries*) using a vacuum packing machine. Czech Journal of Food Sciences, 31(1):94-98.

Maeda, Kiminori, Henbest Kevien B, Cintolesi, Filippo, Kauprop, Llya, Rodjers, Christopher T, Liddell, Paul A Gust Devens Timmiel, R. Christian and P.J. Hore (2008). Chemical compass model of avian magnetoreception. Nature, 453(7193):387-390.

Nabeel, K. Al Ain (2010). Effect of magnetic field on mites. J. Al Nahrain University, 13 (3)04-109.

Ou JunJun, Zhu Xiaokun, Wang Lei, Xu Chuan, Liu Feng, Ren Long, Xu XiBao, Wang Yi, Rui Chang Hui, Liu Shang Zhong (2012). Synthesis and bioactivity study of 2-acylamino-substituted N'-benzylbenzohydrazide derivatives. Journal of Agricultural and Food Chemistry ; 60(44):10942-10951.

Paz, H., M. A. Vargas, O. A. Forero, J. F. Pabon and J.A. Plaza (2012). Local distortion of the earth's magnetic field as a proposal for handing the leafcutter ant species *Atta* spp. (Hymenoptera : Formicidate). Ingenieria e Investigation Journal, 32(2):28-33.

Posfai, M. and R. E. Dunin-Borkowski (2009). Magnetic nanocrystals in organisms. Elements, 5(4) : 235-240.

Reguzzi, M.C., S. Gariboldi and E. Chiappini (2011). Preliminary observations on the use of low temperatures in the cultural heritage protection. Journal of Entomological and Acarological Researsh, 43(2):191-196.

Rocketein, M. (1974). on the Physiology of Insects, 2nd Edition Academic press, Inc.

Shrikant, Mohan, S. and K. Ramaraju (2012). Occurrence of insects in stored cocoa beans in Tamil Nadu, Madras Agricultural Journal, 99(7/9):586-587.

Vacha, M., T. Puzova and D. Drstkova (2008). Ablation of antennae does not disrupt magnetoreceptive behavioral reaction of the American cockroach to periodically rotated geomagnetic field, Neuroscience Letters, 435(2):103-107.

Wijenberg, Rosanna, Hayden, Michael E, Takacs, Stephen and Gries, Gerhard (2013). Behavioral responses of diverse insect groups to electric stimuli, Entomologia Experimentalis et Applicata, 147(2):132-140.

Win, T.D. (2010). Pesticides. AU Journal of Technology, 14(1)47-55

Xie Chunlan, Li Zhiyi, Sui He, Pan WeiDong and Chen Fajun (2011). Detection of magnetic materials in adults of the brown planthopper, *Nilaparvata lugens* (Hemiptera: Delphacidae). Acta Entomologica Sinica 54(10):1189-1193.

Zhu Lin Xue Shaoping, Yan Qinlao, Chen Jun and Yang Zhonghao (2011). Experiment on killing and controlling cucumber pests by high voltage static electricity. Transactions of the Chinese Society of Agricultural Engineering, 27(12):152-155.

الفوائد المحتملة لاستخدامات المغناطيسية في مجال وقاية النباتات

عبد الخالق محمد حسين ، محمد عرفة عويس ، سلوى سيد محمد عبد الصمد ، عادل السيد حاتم

معهد بحوث وقاية النباتات – مركز البحوث الزراعية – مصر

الملخص العربي

تم اختبار 4 حشرات هامة اقتصادياً لاختبار أثر (المجال المغناطيسى) على فقس وتطور بيض هذه الحشرات وفى تجربة معملية كاملة العشوائية بمكررات ثلاث وعلى مدى 10 أيام لملاحظة بيض كل من (فراشة الحبوب)

(وطفيل الترايكوجراما) و(دودة ورق القطن الكبرى) وأخيراً (دودة القطن الصغرى) مع تعريض كل مجموعة من البيض على حدة للمعاملات صفر (كنترول) ،1 ، 5 ، 11 وحدة مغناطيس (كل وحدة قوتها 14- 16 مل تسلا) وعلى مدى الأيام العشرة تم الفحص المجهرى يومياً ورصد وتسجيل النسبة المئوية للفقس والتطور وحالة اليرقات (من موت و/ أو حياه) وهى تحت ظروف المعاملات الموضحة سابقاً .

واظهرت النتائج : أن هناك نقصاً متزايداً فى نسبة فقس البيض مع زيادة شدة المجال المغناطيسى وكانت أكثر الحشرات حساسية واظهرت نقصاً فى نسبة الفقس هى : فراشة الحبوب (السيتوتروجا) حيث كانت نسبة الفقس فى الكنترول 90% وانخفضت تحت مجال مغناطيسى (11وحدة) إلى 22% فقط بفارق قدره 68% . وفى دودة ورق القطن الكبرى إنحفضت من 95.2% في المقارنة (بدون مجال مغناطيسى) الى 56.8% تحت مجال (11 وحدة مغناطيس) وفى دودة ورق القطن الصغرى انخفضت من 90% فى المقارنة (بدون مجال مغناطيسى) الى 50.86%. وأخيراً انخفضت نسبة الخروج والتطور للترايكوجراما تحت المجال المغناطيسى (11وحدة) إلى 47.06% مقارنة بـ 82.31% فى معاملة المقارنة (بدون مجال مغناطيسى).

لاشك فى قلة البحوث فى هذا المجال على مستوى العالم وكذلك فى ندرتها فى مصر ولذلك فإن المزيد من البحوث فى هذا المجال مطلوبة لاستخدام (تأثير المجال المغناطيسى المتزايد) حتى نقلل فقس بيض بعض الحشرات أما للحد من كثافة الحشرات الضارة مثل دودة ورق القطن أو للاستفادة بالبيض (قبيل الفقس) كما فى حالة السيتوتروجا والترايكوجراما ومن الطموح ان يتم عمل مصيدة تعتمد على فكرة المجال المغناطيسي الصناعي(الكهربي) لتدمير بيض الحشرات في المزروعات الحقلية .

Table (1) : Effect of magnetic field on egg hatchability of Sitotroga ceralella

Treatments	0				1				5				11			
Da ys of observation	newly emerged individuals	Total Number of living indviduals	dead individual	Emergency Percentage	newly emerged individuals	Total Number of living indviduals	dead individual	Emergency Percentage	newly emerged individuals	Total Number of living indviduals	dead individual	Emergency Percentage	newly emerged individuals	Total Number of living indviduals	dead individual	Emergency Percentage
1	90	90	-	90%	87	87	-	87%	70	70	-	70%	22	22	-	22%
2	-	85	5		-	77	10		-	61	9		-	12	10	
3	-	73	12		-	60	17		-	47	14		-	10	2	
4	-	51	22		-	39	21		-	26	19		-	6	4	
5	-	28	23		-	12	27		-	12	24		-	1	5	
6	-	12	16		-	7	5		-	7	5		-	-	1	
7	-	3	9		-	6	7		-	3	4		-	-	-	
8	-	1	2		-	-	1		-	2	1					
9	-	-	1		-	-	-		-	-	2					
10	-	-	-							-	-					
Starting egg number				100				100				100				100
Hatchability Percentage %				90				87				70				22%
Total observation Period (day)				10				10				10				10
Period before death (day)				9				8				9				6
Hatching Period (day)				1				1				1				1

Table (2) : Effect of magnetic field on egg hatchability of *Trichogramma evanescens*

Treatments	0				1				5				11			
Days of observation	newly emerged individuals	Total Number of living indviduals	dead individual	Emergency Percentage	newly emerged individuals	Total Number of living indviduals	dead individual	Emergency Percentage	newly emerged individuals	Total Number of living indviduals	dead individual	Emergency Percentage	newly emerged individuals	Total Number of living indviduals	dead individual	Emergency Percentage
1	269	269	-	53.80%	240	240	-	48.00%	211	211	-	42.20%	205	205	-	41.00%
2	146	415	-	83.00%	137	377	-	75.40%	99	310	-	62.00%	60	265	-	53.0%
3	62	477	-	95.40%	54	431	-	86.20%	31	341	-	68.20%	19	284	-	56.80%
4	-	477	-	95.40%	-	431	-	86.20%	-	341	-	68.20%	-	284	-	56.80%
5	-	288	189		-	267	164		-	185	156		-	140	144	
6	-	138	150		-	123	144		-	77	108		-	39	101	
7	-	18	120		-	11	112		-	3	74		-	4	35	
8	-	8	10		-	3	8		-	-	3		-	-	4	
9	-	-	8		-	-	3		-	-	-		-	-	-	
10	-	-	-		-	-	-		-	-	-		-	-	-	
Starting egg number				500				500				500				500
Maximum emergency Percentage				95.4%				86.2%				68.2%				56.8%
Total observation Period (day)				10				10				10				10
Emergency Period (day)				4				4				4				4
Period before death (day)				9				9				8				8

Table (3) : Effect of magnetic field on egg hatchability of *Spodoptera littoralis*

Treatments	0			1			5			11		
Days of observation	newly Hatched eggs	Total living Larvae	Hatchability %	newly Hatched eggs	Total living Larvae	Hatchability %	newly Hatched eggs	Total living Larvae	Hatchability %	newly Hatched eggs	Total living Larvae	Hatchability %
1	150	150	38.46	0	0	0	0	0	0	0	0	0
2	160	310	79.49	275	275	64.71	333	333	63.43	253	253	48.19
3	1	311	79.74	10	285	67.06	15	348	66.29	9	262	49.90
4	15	326	83.59	-	285	67.06	-	348	66.29	5	267	50.86
5	20	346	88.72	18	303	71.29	5	353	67.24	-	267	50.86
6	5	351	90	-	303	71.29	-	353	67.24	-	267	50.86
7	-	351	90	6	309	72.71	-	353	67.24	-	267	50.86
8	-	351	90	-	309	72.71	-	353	67.24	-	267	50.86
9	-	351	90	-	309	72.71	-	353	67.24	-	267	50.86
10	-	351	90	-	309	72.71	-	353	67.24	-	267	50.86
Starting egg number			390			425			525			525
Final hatchability Percentage			90			72.71			67.24			50.86%
Hatching Period (Days)			6			6			4			3

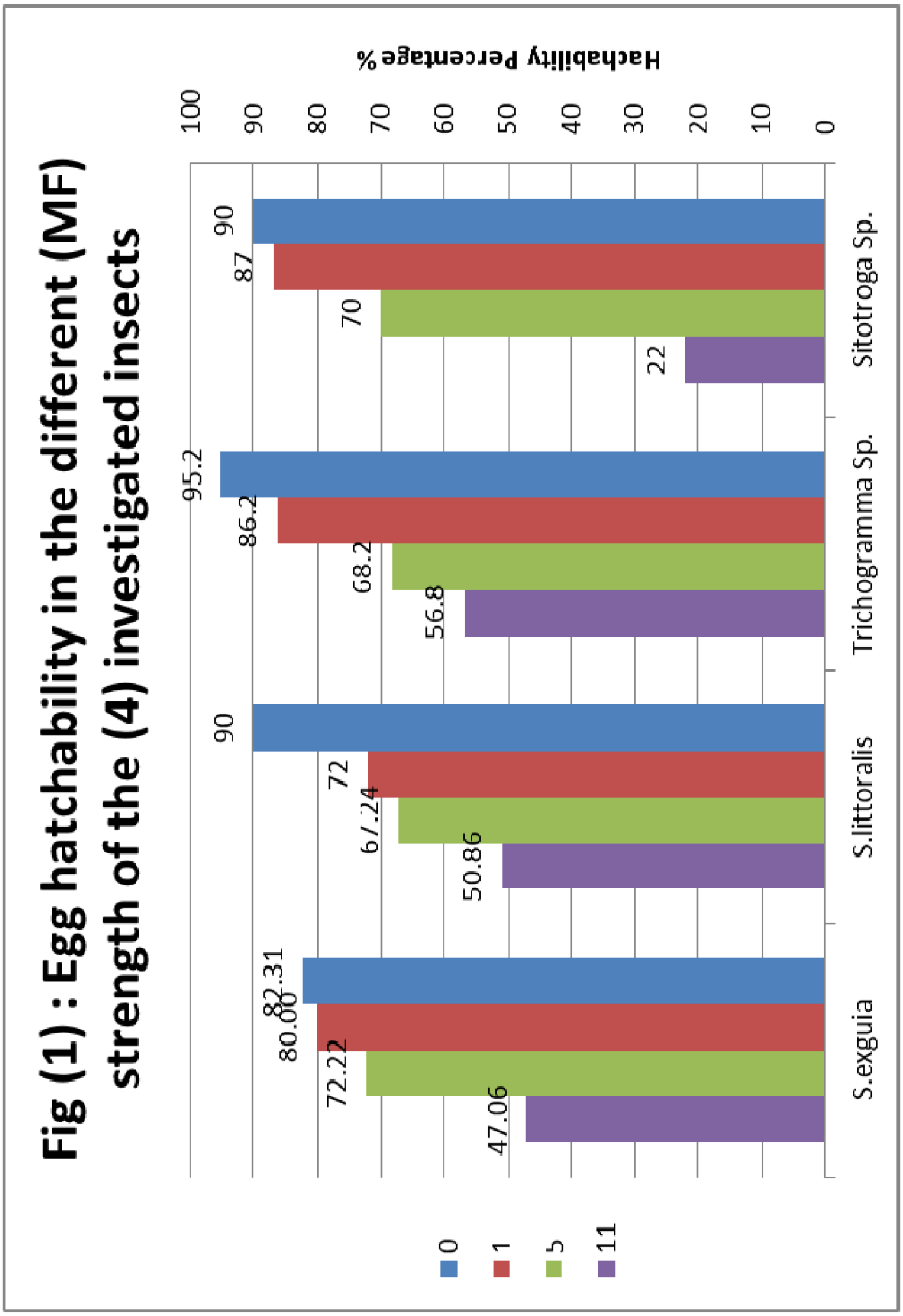

Fig (1) : Egg hatchability in the different (MF) strength of the (4) investigated insects

Table (4) : Effect of magnetic field on egg hatchability of *Spodoptera exigua*

Treatments	0			1			5			11		
Days of observation	**newly hatched eggo**	**Total living Larvae**	**Hatchability %**	**newly hatched eggo**	**Total living Larvae**	**Hatchability %**	**newly hatched eggo**	**Total living Larvae**	**Hatchability %**	**newly hatched eggo**	**Total living Larvae**	**Hatchability %**
1	21	21	16.15	50	50	37.04	25	25	13.89	20	20	17.65
2	81	102	78.46	5	55	40.74	55	80	44.44	30	50	29.41
3	5	107	82.31	48	103	76.30	50	130	72.22	30	80	47.06
4	-	107	82.31	-	103	76.30	-	130	72.22	-	80	47.06
5	-	107	82.31	5	108	80.00	-	130	72.22	-	80	47.06
6	-	107	82.31	-	108	80.00	-	130	72.22	-	80	47.06
7	-	107	82.31	-	108	80.00	-	130	72.22	-	80	47.06
8	-	107	82.31	-	108	80.00	-	130	72.22	-	80	47.06
9	-	107	82.31	-	108	80.00	-	130	72.22	-	80	47.06
10	-	107	82.31	-	108	80.00	-	130	72.22	-	80	47.06
Starting egg number			130			135			180			170
Max. hatchability %			82.31%			80%			72.22%			47.06%
Hatching Period (days)			3			5			3			3

Table (5-a) : Effect of magnetic field on egg hatchability of *the insects under investigation*

Parameters / Treatment	*insects :*	*Total observation Period (day)*	*Period of hatching and / or emergency (day)*	*Period before death (day)*	*Starting egg Number*	*Hatched egg Number*	*Emergency and / or Hatchability Percentage*
Control (0)	*Sitotroga ceralella*	10	1	9	100	90	90%
	Trichogramma evanescens	10	4	9	500	477	95.2%
	Spodoptera littoralis	10	6		390	351	90%
	Spodoptera exigua	10	3		130	107	82.31%
1 mag.u.	*Sitotroga ceralella*	10	1	8	100	87	87%
	Trichogramma evanescens	10	4	9	500	431	86.2%
	Spodoptera littoralis	10	6		425	309	72.71%
	Spodoptera exigua	10	4		135	108	80%
5 mag.u.	*Sitotroga ceralella*	10	1	9	100	70	70%
	Trichogramma evanescens	10	4	8	500	341	68.20%
	Spodoptera littoralis	10	4		525	353	67.24%
	Spodoptera exigua	10	3		180	130	72.22%
11 mag.u.	*Sitotroga ceralella*	10	1	6	100	22	22%
	Trichogramma evanescens	10	4	8	500	284	56.80%
	Spodoptera littoralis	10	4		525	267	50.86%
	Spodoptera exigua	10	3		170	80	47.06%

mag.u. : magnet unit