EFFICIENCY OF TWO NOVEL BIOTIC COMPOUNDS AGAINST THE LABORATORY AND FIELD STRAIN OF THE COTTON LEAFWORM, *Spodoptera littoralis* (Boisd.)

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Abstract

The efficiency of two novel compounds (takumi, and radiant) and conventional insecticide (methomyl) against the second and fourth instars of the laboratory and field strains of *Spodoptera littoralis* was evaluated under laboratory conditions through determination their LC50 values. Radiant was the most toxic one against both of 2nd and 4th larval instars of the laboratory and field strains. The LC_{50}values were 0.06, 1.95(2nd instar) and 5, 10 ppm (4th instar) of laboratory and field strains, respectively. Takumi was the second one with the LC_{50}values of 0.12, 2.4 and 9.0, 19 ppm for the two instars of both strains, respectively. Lannate was the least one, its LC50values were 5.86, 10 and 46.9, 93.8ppm, respectively.

All the treated larvae were biologically affected by the three tested compounds. The effect varied according to the strain, larval instars and tested compound. Therefore, the treated larvae were resulted in decreased pupation and adult emergence percentages. Also, the larval treatment of field strain treated with takumi induced the longest period of the larval duration. While, the 2nd larval instar treatments had the highest effect in the pupal period increase. Hence, the larval treatment of the laboratory strain had the strongest effect in the pupal weight decrease. The 2nd instar of the field strain treated with radiant and the 4th instar of the same strain treated with takumi caused the highest percent of pupal malformations, hence, the 2nd instar of the laboratory strain treated with methomyl and the 4th instar treated with takumi induced the greatest percent of adult malformations. Also, the 4th instar of the field strain treated with takumi had the strongest effect in adult fecundity reduction..

INTRODUCTION

The cotton leafworm, *Spodoptera littoralis (*Boisd) is one of the major notorious and destructive phytophagous insect pests that cause a considerable damage to many of the important vegetable and field crops in Egypt (Kandil *et. al.,* 2003). The rising consumption of currently used insecticides in developing countries has led to a number of problems such as insect resistance, environmental pollution and the health hazards associated with pesticide residues. It is therefore necessary to complement our reliance on synthetic pesticides with less hazardous, safe and biodegradable

substitutes. Flubendiamide, a novel class insecticide possessing a unique chemical structure, a new, promising class of insecticides called 1, 2-benzenedicarboxamides or phthalic acid diamides, with exceptional activity against a broad spectrum of lepidopterous insects. It was discovered by Nihon Nohyaku Co., Ltd., and was registered in Japan in 2007 under the trade name of Phoenix WDG (Kintscher *et. al.*, 2007 and Tohnishi *et. al.* 2010). Spinetoram is a new member of the spinosyn class of insect management tools developed by Dow Agro Sciences Company. It is derived from fermentation of *Saccharopolyspora spinosa* as are other spinosyns, but fermentation is followed by chemical modification to create the unique active ingredient in spinetoram. In Egypt, Temerak (2007) used the spinosyn products, spinosad and spinetoram to combat egg masses of cotton leaf worm; he indicated that Radiant SC12% was 5 and 7 times stronger than spintor SC24% in the field and laboratory, respectively. Thus, this product have an excellent activity against a wide range of lepidopterous pests on many field crops such as vegetables, fruits, tea, cotton, and rice (Hirooka *et. al.*, 2007).It is applied at low rates and has low impact on most beneficial insects (Mertz and Yao, 1990)**.** Pests controlled by spinetoram include beet army worm, *Spodoptera exigua,* thrips, *Frankliniella spp.,* cabbage looper, *Trichoplusia ni* and codling moth, *Cydia pomonella.* It causes excitation of the insect nervous system by altering the function of nicotine and GABA-gated ion channels (Crouse and Sparks, 1998). The conventional insecticide, lannate was used for the lepidopterous pests control (Kassem *et. al.*, 1986).

The aim of the present study is to compare the insecticidal efficacy of two novel compounds takumi and radiant in relative to the conventional insecticide lannate against the second and fourth instar larvae of the field and laboratory strains of S*. littoralis*(Boisd).

MATERIALS AND METHODS

1. The Field strains.

Field strain egg masses of cotton leafworm (CLW) were collected from cotton fields at Sides Research Station, Beni-Suef during 2009-2010 cotton growing seasons. The egg-masses were collected during June and reared on castor bean leaves *Ricinus communis* (L.) under temperature ranged between 25– 28C and 60–65 % relative humidity until egg hatching. The obtained second and fourth instar larvae were used for bioassay tests.

2. The laboratory strains.

The culture of the cotton leafworm, *Spodoptera littoralis* (Boisd) was initiated as larvae supplied from the division of cotton leafworm of plant protection research Institute, Dokki, Egypt. The cotton leafworm, *S.littoralis* was reared in the laboratory for several generations at room temperature ranged between 25 - 28 Ċand 60 -65% R.H. Larvae were fed on castor bean leaves, *Ricinus* communis (L.) in a wide glass jars until pupation period and adults emergence. The newly emerged adults were mated inside glass jars and supplied with a piece of cotton wetted with 10% sugar solution as feeding source for the emerged moths and branches of Tafla (*Nerium oleander* L.) or castor bean leaves as an oviposition site (El- Defrawi *et. al.*,1964). Egg masses were kept in plastic jars until hatching. The obtained second and fourth instar larvae were used for bioassay tests.

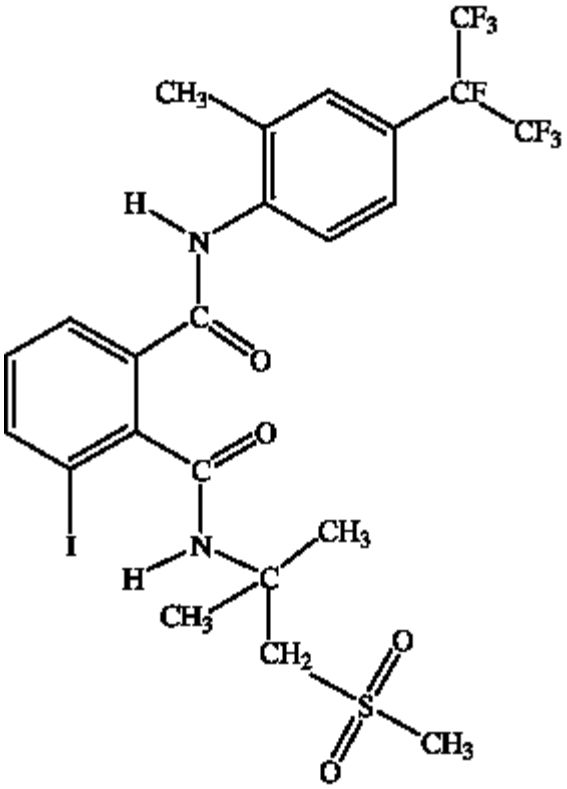
2-Materials used:

2.1– Takumi

Common name: Takumi

Chemical name: Flubendiamide

MOLECULAR FORMULA: $C_{23}H_{22}F_7IN_2O_4S$



2.2-Radiant

Common name: Radiant

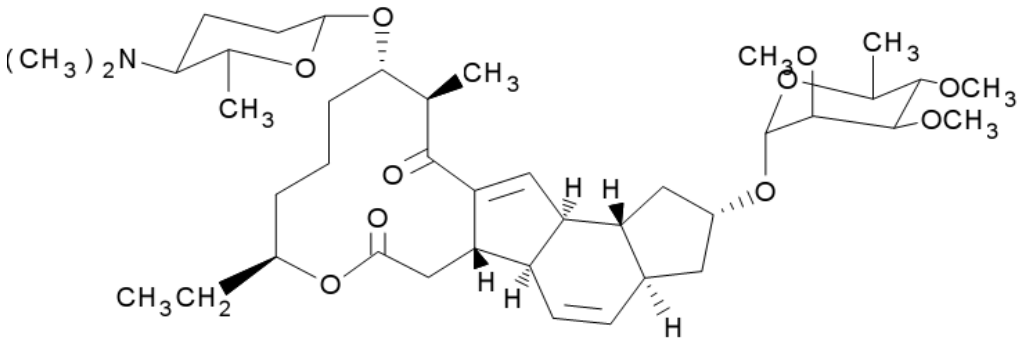
Chemical name: Spinetoram (XDE-175-J)

Spinetoram is the second generation of the spinosyn group. It is a trademark of Dow AgroSciences. Spinetoram is prepared from a mixture of two natural spinosyns, spinosyns J and L produced by *S. spinosa*.

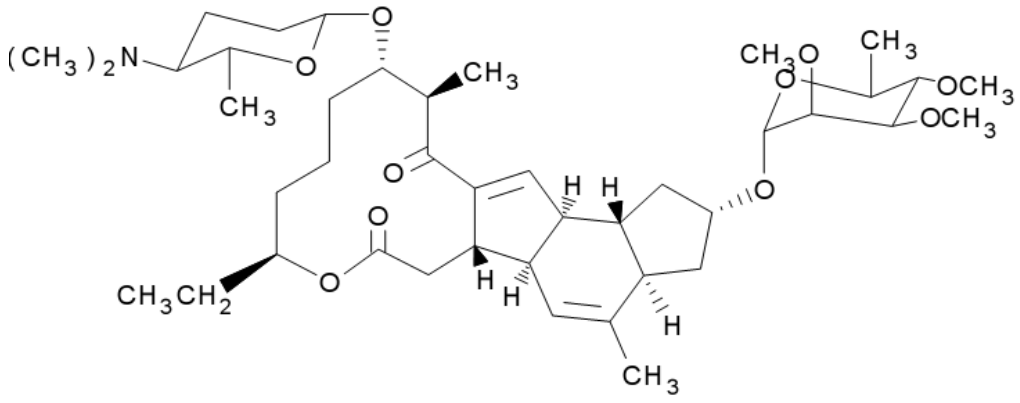
Major component (3'-ethoxy-5,6-dihyro spinosyn J).

Minor component (3'-ethoxy spinosyn L).

Molecular formula: C43H69NO10 and C42H69NO10



spinosyn A



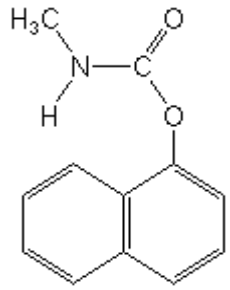
spinosyn D

2.3- Lannate (90%) k.z.

Common name: Lannate

Chemical name: thioacetimidate methyl N (methylcarbamoyloxy)

Molecular formula: C5H10N2O2S



3- Test producers

A series of different concentrations of each of the three tested compounds takumi, radiant, and lannate were prepared on the active ingredient basis (p. p. m) using water as a solvent for dilution. Both takumi and radiant were tested at 62.5, 31.25, 15.6, 7.8, 3.9, 1.95and 0.977p.p.m for the second and fourth instar larvae of the field strain. On the other side, both the 2nd and 4th instar larvae of laboratory strain treated with takumi and radiant were tested at 7.8, 3.9, 1.95, 0.977, 0.488 , 0.244, 0.122and 0.06ppm.While, lannate was tested at 375, 187.5, 93.8, 46.9, 23.4, 11.7and 5.9p.p.m for the two instars of field strain. And it was tested at 23.438, 11.719, 5.859, 2.929 and 1.465p.p.m for the 2nd and 4th instar of laboratory strain. The leaves of castor were dipped for 15 seconds in each concentration, then left to dry in air current for about 1hr. Also, castor leaves were dipped in only distilled water and used as control. About forty larvae in four replicates of each second and fourth instar larvae of both susceptible (laboratory) and resistant (field) strains for all treatments including the control were used(ten larvae for each replicate). After 24hour the treated leaves was replaced by other untreated ones and the larvae fed on it until the pupation .The jars were examined daily to determine the larval mortality. The different biological effects such as larval and pupal duration, pupation and adults emergence percentage, pupal weight, adult fecundity, fertility, longevity, sex ratio were determined at the LC50 values of the three treatments. Also, the observed malformations were recorded and photographed.

***4-Statistical analysis*:**

The total percent of the larval mortality of the three tested compounds were recorded after 24hour of the larval feeding of both second and fourth instars of both

susceptible and field strains of the three tested compounds and corrected according to Abbott formula (Abbott, 1925). The data were then analyzed using the probit analysis (Finney, 1971) and the LC50 values of the three tested compounds were estimated for both strains. The different biological effects on larval and pupal duration, pupation and adult emergence percentage, adult fecundity, fertility, longevity, sex ratio were estimated at the LC50 values. The obtained data of the biology were statistically calculated through Excel for windows computer program to determine the F-value, P-value and L.S.D (least significant difference) at 0.05 or 0.01 level.

RESULTS AND DISCUSSION

1-Insecticidal activity:

Data in Table (1) showed radiant was the most toxic compound against both 2nd and 4th instar larvae of laboratory and field strains. The LC_{50}values were 0.06, 1.95 and 5, 10 ppm for both second and fourth instar larvae of laboratory and field strains, respectively .While, takumi was the second insecticide, and the LC_{50}values were 0.12, 2.4 and 9, 19 ppm, respectively. Whereas, lannate was the least one, its LC_{50} values were 5.86, 10 and 46.9, 93.8ppm, respectively.

Table 1. Biological activity of Takumi, Radiant and Lannate at their LC50 values against the 2nd instar larvae of laboratory and field strains of *Spodoptera littoralis*

Treatment	Strain	2nd instar				4th instar			
		LC50 values P.p.m	Slope function	95% confidence limit		LC50 values P.p.m.	Slope function	95% confidence limit	
				Upper	Lower			Upper	Lower
Takumi	Lab.	0.12	3.4	0.3	0.045	2.4	3.46	6	0.96
	Field	9.00	4.2	23.4	4	19	6.86	20	17
Radiant	Lab.	0.06	6.7	0.17	0.02	1.95	2.44	4	0.929
	Field	5.00	3.2	15.5	1.61	10	3.4	11	9
Lannat	Lab.	5.86	2.6	11.1	3.1	10	3	21	4.8
	Field	46.9	4.6	51.7	42.7	93.8	4.5	103.1	85.2

These results are in agreement with those of Hamouda and Dahi. (2008) who indicated that spinetoram is a fairly toxic with LC50 (1.11 ppm) when tested against the 4th instar of S. *littoralis*. While, Elbark *et. al. (*2008) reported that the LC_{50} of the 2nd and 4th larval instars of *S. littoralis* treated with radiant after 24hour were 0.05 and 6.67 ppm, repectively. Also, Hassan (2009) estimated the LC50 of the second instar larvae of *S. littoralis* treated with spinetoram for 48hour ranged from 0.022 to 0.033ppm And it ranged from 1.78 to 2.64ppm of the 4th instar treated with spinetoram.

2. Latent effect:

2.1. Larval and pupal periods:

Data in Tables (2 and 3) indicated that the larval treatment of both 2nd and 4th instars of the field and laboratory strains at LC_{50} values highly significantly ($p<0.01$) increased the larval duration.

Tables (2 and 3) showed that the treatment of both 2nd and 4th instars larvae of laboratory and field strains with the three tested compounds highly significantly ($p<0.01$) increased the pupal duration. .

These results agree with that obtained by El-Barkey *et. al.*(2009) who showed a prolongation in larval and pupal developments resulted from eggs of *Pectinophora gossypiella* at one, two and prehatching days old treated by Radiant, estimated by 20.8, 18.5 and 8.2 days, respectively for larvae and 8.9, 8.8 and 7.9 days for pupae.

Table 2. Biological activity of Takumi ,Radiant and Lannate at their LC50 values against the 2nd instar larvae of laboratory and field strains of *Spodoptera littoralis* .

Treatment	Strain	Larval duration (days) ± SD	Pupation%		Pupal duration (days) ± SD	Pupal weight (mg) ±S.D	Adult emergence % ±S.D	
			Normal Mean± SD	Malfo			Normal	Malfo %
Takumi	Lab.	13.5+2**	40+15**	10	9.9+2**	241+15.8**	50+10**	0
	Field	18.6+3**	45+5**	10	7.8+0.8**	340+108**	70+10**	10
Radiant	Lab.	13.3+2**	40+5**	0	9.1+0.2**	166+21**	35+5**	10
	Field	15+1.4**	55+5**	15	9.5+1.5**	420+50**	85+5**	10
Lannate	Lab.	13.6+2**	35+5**	0	9.4+0.8**	145+29**	50+5**	20
	Field	16.2+1**	50+5**	10	8+0.86**	337+71**	65+5**	0
Control	Lab.	11.8+1.5	100	0	6.6+0.1	360+75.3	100	0
	Field	13.7+0.9	100	0	5.3+1.2	520+32	100	0
F value	Lab.	8.0696	559.9201		120.89	16.346	265.81	
	Field	48.73	469.0894		52.78	39.408	60.197	
P value	Lab.	0.0249	0.000460		0.00010	0.0341	0.006572	
	Field	0.001514	0.000462		0.0105	0.00343	0.0282	
L.S.D.at.05	Lab.	1.406	10.48		1.167	123.2	11.003	
	Field	0.922	8.47		1.07	66.92	11.002	
L.S.D.at.01	Lab.	1.995	19.3		1.76	204.3	20.18	
	Field	1.28	15.6		1.52	110.99	20.2	

.** = Highly Significant ($p<0.01$) * Significant ($p<0.05$)

S.D.=Standard deviation Malfo.= Malformation%

L.S.D.= Least significant difference Lab.=Laboratory strain

n. s=none Significant ($p>0.05$)

Table 3. Biological activity of Takumi, Radiant and Lannate at their LC50 values against the 4th instar larvae of laboratory and field strains of *Spodoptera littoralis*

Treatment	Strain	Larval duration (days) ± SD	Pupation %		Pupal duration (days) ± SD	Pupal weight (mg) ±S.D	Adult % emergence ±S.D	
			Normal Mean± SD	Malfo			Normal	Malfo
Takumi	Lab.	12.4+2**	45+5**	10	6.4+0.9n.s	185+77**	35+5**	20
	Field	16.3 +2**	55+5**	16.7	6.9+0.5**	360+29**	80+10**	20
Radiant	Lab.	11.8+3**	40+10**	10	7.3+2.4**	141+61**	40+1.5**	10
	Field	14+2.7**	65+5**	0	9+0.7**	380+18**	45+5**	10
Lannate	Lab.	15+0.6**	40+10**	0	7.8+0.5**	166+9**	48+11**	0
	Field	14.6+2**	65+5**	10	7+0.3**	390+22**	65+5**	10
Control	Lab.	9.3 +1	100	0	5.5+1.9	420+22	100	0
	Field	10.1+1.0	100	0	5.1+2.3	560+49	100	0
F value	Lab.	57.982	198.1081		14.878	26.49	1969.1	
	Field	56.26916	195.34		18.84	16.360	239.4	
P value	Lab.	0.002943	0.00685		0.00598	0.0157	0.00546	
	Field	0.000472	0.00574		0.01137	0.0281	0.00501	
L.S.D.at.05	Lab.	1.401	13.7		1.45	127.7	7.13	
	Field	1.22	7.9		1.619	114.0	6.393	
L.S.D.at.01	Lab.	2.07	23.9		2.15	211.8	11.84	
	Field	1.69	14.5		2.30	189.1	10.6	

** = Highly Significant (p<0.01) * Significant (p<0.05)
S.D.=Standard deviation Malfo.= Malformation%
L.S.D.= Least significant difference Lab.=Laboratory strain
n. s=none Significant (p>0.05)

2.2. Pupation and adult emergence:

Data in Tables (2 and 3) demonstrated that the treatment of the second and 4th instar larvae of both laboratory and field strains with the three tested compounds, takumi,radiant**,** and methomyl at their LC50 values, caused highly significant (p<0.01) reduction of the pupation percentages ,as compared to control .

Data in Tables the same showed that the treatment of the second and fourth instar larvae of both laboratory and field strains with the three tested compounds, at their LC50 values, highly significantly ($p<0.01$) reduced the adult emergence percentages as compared to that of the check.

These results are in agreement with those obtained by Ahmed (2004) who found that the average percentage of pupations and adult emergence for pink and spiny bollworms gradually decreased with increasing concentrations of the tested compounds (Agerin, Diple 2x Naturalis L, Spinosad) in laboratory and field strains.

2.3. The Pupal weight:

The treatment of the second and fourth instar larvae of the laboratory and field strains with takumi, radiant**,** and methomyl at their LC50 values highly significantly ($p<0.01$) reduced the weight of the resulting pupae. The 2nd and 4th instar larvae of the laboratory strain treated with the three tested compounds had the highest effect in the pupal weight decrease.

These results are in accordance with those obtained by Ahmed (2004) who recorded that the Spinosad, Agerin and Cascade treatments caused a significant gradual reduction in pupal weight of pink and spiny bollworms in the laboratory and field strains, while Tagetes oil was the least effective one.

2.4. Morphogenetic effects:

Data presented in Tables (2&3) showed that the larval treatment of 2nd and 4th instars of laboratory and field strain of *S. littoralis* with the three tested compounds at the LC50 values induced a noticeable increase in the pupal and adult malformations, as compared to the check.

These results are similar to those obtained by Ahmed (2004) who reported that Spinosad gave malformed pupal and adults in both laboratory and field strains of both Pink and Spiny bollworms.

Malformations of *S .littoralis* pupae resulting from the larval treatment of 2nd and 4th instars of both field and laboratory strains with takumi appeared as larval -pupal intermediates with larval cuticle patches, head capsule and thoracic legs; posterior half of the body has the pupal properties (fig.1). While, the moth malformations appeared with body bear abnormal mouth parts and malformed twisted wings(fig2,3).On other hand, the larval treatment of 2nd and 4th instars of both field and laboratory strains with Radiant showed as larval-pupal monstrosity with larval cuticle patches and pupal abdomen (fig.4)and malformed adults had abnormal body and wings (fig.5and6).Whereas the larval treatment of 2nd and 4th instars of both field

and laboratory strains with methomyl appeared as pupae with complete blackening of the body leading to death(fig.7).While, malformed adults appeared as moths with deformed twisted wings(fig.8),as compared to normal pupae and adults(fig.9 and10) of control . .

Table 4. Biological activity of Takumi, Radiant and methomyl against the adults of *Spodoptera littoralis* treated as 4th instar larvae of laboratory and field strains with the LC_{50} values..

Treatments	Strain	Fecundity	Fertility	Longevity	Adult sex ratio (%)	
		Mean±S.D. (eggs/f)	Mean±S.D (eggs/f)	Mean±S.D (days)	Male	Female
Takumi	Lab.	30+1.4**	21.3+2**	6.2+2.3**	38.5	61.5
	Field	0+0**	0+0**	6+2.4*	50	50
Radiant	Lab.	89+2**	66+1.4**	6.1+1.1**	62.5	37.5
	Field	91+0.7**	68+11**	3.8+1**	51.9	48.1
Lannate	Lab.	74+13**	61+1.4**	8+1.6n.s	44.4	55.6
	Field	101+1.4**	94+5**	6.4+0.9n.s	47.8	52.2
Control	Lab.	479+228.1	466+220	8.3+1.4	60	40
	Field	340.4+93	330+86.4	7.1+3.1	60	40
F value	Lab.	437.6	646.4	7.8083		
	Field	850.317	1828.7	8.523282		
P value	Lab.	0.0327	0.0252	0.0210		
	Field	0.0223	0.0143	0.019307		
L.S.D.at.05	Lab.	89.1	57.7	1.8		
	Field	33.4	68.1	4.39		
L.S.D.at.01	Lab.	213.4	133.1	2.58		
	Field	76.9	157.1	7.29		

** = Highly Significant (p<0.01) * Significant (p<0.05) S.D.=Standard deviation
Malfo.= Malformation%
L.S.D.= Least significant difference Lab.=Laboratory strain
n. s=none Significant (p>0.05)

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2.5. Adult fecundity and fertility:

Data presented in Table (4) indicated that the treatment of the fourth instar of laboratory and field strains of *S. littoralis* with takumi, radical and methomyl highly significantly ($p<0.01$) reduced the adult fecundity. And the 4th instar larvae of the field strain treated with takumi had the strongest effect in adult fecundity reduction to reach zero, as compared to 340.4 eggs/f of control. While, the larval treatment of the same instar of the same strain with radiant and methomyl decreased the adult fecundity to average 91 and 101 eggs/f, respectively, as compared to that of control (340.4 eggs/f).Also, the treatment of laboratory strain of the same instar with the three tested compounds decreased the adult fecundity to average 30, 89 and 74 eggs/f, respectively, as compared to 479 eggs/f of control.

Likewise, the treatment of the fourth instar of both laboratory and field strains of *S. littoralis* highly significantly ($p<0.01$) reduced the adult fertility. And the 4th instar larvae of the field strain treated with takumi had the highest effect in eggs hatching reduction to reach zero, as compared to 330 eggs/f of control. While, the larval treatment of the same instar of the same strain with radiant and methomyl decreased the adult fertility to average 68 and 94 eggs/f , respectively ,as compared to that of control(330 eggs/f). Also, the treatment of laboratory strain of the same instar with the three tested compounds decreased the adult fertility to average 21.3, 66 and 61 eggs/f, respectively, as compared to 466 eggs/f of control.

These results are in agreement with those obtained by Pineda *et. al.(*2007) who reported that Spinosad and methoxyfenozide reduced in a dose-dependent manner the fecundity and fertility of *S. littoralis* adult when treated oral and residually .Also ,Ahmed (2004) mentioned that the number of eggs produced by spiny bollworm females resulting from the treated larvae with the Spinosad for laboratory and field strains larvae was decreased per female as compared with the control. He indicated that the average % hatchability for the eggs of treated females in both strains was decreased in both of the pink and spiny bollworms as compared with control. Also, El-Barkey *et. al.*(2009) demonstrated a high reduction in the total eggs laid, percentage of hatchability of *Pectinophora gossypiella* eggs treated by Radiant.

2.6. Adult longevity:

Data obtained in Table (4) showed that the treatment of the fourth instar of field strain of *S. littoralis* with radiant highly significantly ($p<0.01$)reduced the adult longevity to average 3.8 days as compared to 7.1 days of control. While the larval treatment of the fourth instar of the same strain with takumi significantly ($p<0.05$) decreased the adult longevity to 6 days, as compared to that of control (7.1days).Whereas the treatment of the fourth instar of laboratory with takumi and Radiant caused adult longevity shorten averaged 6.2 and 6.1days,respectively,as compared to 8.3 days of control. However, the larval treatment of the 4th instar of both laboratory and field strains with methomyl gave none significant decrease in the adult longevity ,it averaged 8 and 6.4 days, as compared to8.3 and 7.1days of control, respectively .

These results are in agreement with that obtained by El-Barkey *et. al.* (2009) who indicated a high reduction in adult longevity of *Pectinophora gossypiella* resulted from eggs at one, two and prehatching days old treated by Radiant.

2.7. Adult sex ratio:

Data obtained in Table (4) demonstrated that the larval treatment of the fourth instar of both laboratory and field strains with both takumi and methomyl had the highest effect in the sex ratio shifting of adult males and females, it induced males decrease and females increase, as respect to that of control, it reached 38.5:61.5, 50:50 and 44.4:55.6, 47.8:52.2 %of both adult males: females, respectively, as compared to 60:40%that of control. Also, the treatment of the 4th instar of the field strain with radiant had the a similar effect on sex ratio, it induced males decrease to reach 51.9% ,and increased the females to reach 48.1%,as compared to60:40 of both males and females, respectively ,of control. However the larval treatment of 4th instar of the laboratory strain with radiant had adversely effect caused males increase to reach 62.5 and decreased the females to reach 37.5%, as compared to that of control (60:40%, respectively).

2.8. Conclusion:

The results of the present work demonstrated that the three tested compounds were effective against the survival of the 2nd and 4th instar larvae of both susceptible and field strains of *S. littoralis* .Radiant had the highest efficacy against the insect,

while takumi had the next effect against the studied insect biology. These compounds were be effective if applied at the obtained lethal concentrations within the integrate control program of this pest for reduction of classic synthetic insecticides use of serious effects on the environment. Spinetoram has a neurotoxic effect manifested as well defined histopathologiacal changes in nerve and neurosecretory cells of *S. littoralis* (Hamouda and Dahi, 2008).Also, Flubendiamide-treated insects show unique symptoms of poisoning resulting in complete and irreversible contraction paralysis led to the larvae death after few days when it injected *within* the *Spodoptera frugiperda* larvae Ebbinghaus *et. al.* (2007,a,b).

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كفاءة اثنين من المركبات الحيوية الجديدة للسلالة المعملية والحقلية لدودة ورق القطن

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أجريت هذه الدراسة بغرض مقارنة كفاءة أثنين من المركبات ألحديثه وهى التاكومى والراديانت ومبيد تقليدي ،اللأنيت تحت الظروف المعملية. غذيت يرقات العمر الثاني والرابع للسلالة المعملية والحقلية المتحصل عليها في صورة لطع للفقس لمدة 24 ساعة على ورق خروع تم غمره لمدة 15ثانية في سلسلة تركيزات لكل مركب من المركبات الثلاثة المختبرة لتحديد قيم التركيز النصفي لكل مركب. أوضحت النتائج أن مركب الراديانت كان له التأثير الأقوى والغالب ضد كل من العمر الثاني والرابع للسلالتين المعملية والحقلية حيث بلغت قيمة التركيز النصفي القاتل له 0.06,1.95و 5,10ppm للسلالتين ألمعمليه والحقلية للعمرين الثاني والرابع على التوالي وكان لمركب التاكومى التأثير الثاني حيث بلغت قيمة التركيز النصفي له 0.12,2.4و 9,19 ppm للسلالتين للعمرين على الترتيب.بينما جاء مركب اللأنيت بالمرتبة الثالثة حيث بلغت قيمة التركيز النصفي له 5.86,10و46.9,93.8ppm لكل من العمرين للسلالتين على التوالي. تأثرت المعايير البيولوجية لليرقات بعد المعاملة لكل من للعمرين الثاني والرابع للسلالتين المعملية والحقلية بالمركبات الثلاثة. التأثير تنوع مع اختلاف السلالة والعمر اليرقى و مع المركب المختبر أدت إلى خفض نسب التعذير والخروج للحشرة الكاملة .بينما كان لمركب التاكومى التأثير الأقوى في زيادة فترة البقاء اليرقى.كذلك أدت معاملة العمر الثاني للسلالة المعملية والحقلية بالمركبات الثلاثة التأثير الأكبر في زيادة العمر العذري و نقص الوزن العذري بالمقارنة بالكنترول.في حين أن معاملة العمر الثاني للسلالة الحقلية بالراديانت والعمر الرابع لنفس ألسلاله بالتاكومى أنتج النسب الأكبر للعذارى المشوهة .في حين أن معاملة العمر الثاني للسلالة المعملية بالميثاميل والعمر الرابع للسلالة المعملية والحقلية بالتاكومى أعطى النسب الأعلى للحشرات المشوهة. كما أن معاملة العمر الرابع للسلالة الحقلية بالتاكومى كان له التأثير الأقوى في اضمحلال الخصوبة ونسب فقس البيض ليصل إلى الصفر مقارنه 340.4و 330 بيضه لكل أنثى على التوالي بالكنترول.كما إن معاملة العمر الرابع للسلالة الحقلية بالراديانت خفضت معنويا العمر الحشري بالمقارنة بالكنترول. كما إن المعاملة اليرقيه للعمر الرابع للسلالة المعملية والحقلية بالتاكومى واللأنيت كان لهم التأثير الأقوى في تغير النسب الجنسية للذكور والإناث بشكل لافت للنظر بالمقارنة بالكنترول حيث انه أدى ذلك إلى نقص نسب الذكور وزيادة نسب الأثاث بالمقارنة بالكنترول.