Insecticidal activity of Imidacloprid, Diflubenzuron and Diplel DF against the second and fourth instar larvae of cotton leaf worm, Spodoptera littoralis (Boisd.)

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Abstract: The efficiency Imidacloprid , Diplel DF and IGR (Diflubenzuron) against 2nd and 4th instars instars of the laboratory strain of *Spodoptera littoraliis* was evaluated under laboratory conditions. Imidacloprid was the most toxic compound against the 2nd and 4th larval instars of *Spodoptera littoraliis*. The LC_{50} values were 90 and 170 ppm for the two instars, respectively. Whereas Diflubenzuron was the second compound with the LC_{50} values of 150 and 200 ppm, respectively. Diplel DF was the least compound subscribt, LC50 values were 270 and 330 ppm, respectively.

All the treated larvae were biologically affected by the three tested compounds. The effect was varied according to the larval instars and tested compounds. Therefore, the treated larvae were resulted in decreased pupation and adult emergence percentages, and the 2nd instar treated with both Admire and Diflubenzuron had the strongest effect in this respect. The treatment of 2nd instar with the three compounds induced the highest increase larval, pupal duration and adult malformation percentages. While, the 2nd and 4th instars treated with chitun synthesis inhibitors, dimilin induced malformed larval percent, while the treatment of 2nd instar with Imidacloprid induced the highest pupal malformations (20%).Whereas, the larval treatment of 2nd instar with Imidacloprid and Diflubenzuron had the most potent in inhibiting of both the adult fecundity (zero eggs/female) and eggs hatching (0%), in comprison with control (558 eggs/female and 98.3%).Hence, the larval treatment of 2nd and 4th instars with Diflubenzuron and Diplel DF gave the shortest period of adult longevity, as compared to control. The larval treatment of 2nd and 4th instars with the three tested compound increased the adult males and decreased the adult females' percentages, expressed as sex ratio of both males and females of control, therefore, the treatment of 2nd instar with Admire and 4th instar with Diflubenzuron had the strongest effect in this respect.

1. Introduction:

The cotton leaf worm, *Spodoptera littoralis* (Boisd) is a key polyphagous pest in Egypt. Without a hibernation period the cotton leafworm is active all year. It was the most destructive insect pest of great variation of important vegetables and field crops, approximately 112 species belonging to 4411families are attacked by this pest. Among the wide range of hosts, cotton, soybean, maize, wheat and vegetable crops (e.g. tomato, potato and strawberry) are evidently favored by the cotton leaf worm and severe damage is annually caused to most crop growers. However, the increasing consumption of the synthetic pesticides in the developing countries has lead to a number of problems such as environmental pollution, adverse effects on non-target organisms and the development of insect resistance. Progress has been done during the past three decades to develop novel compounds affecting developmental processes in insects such as chitin synthesis inhibitors, juvenile hormone mimics, and ecdysone agonists. This group of insecticides consists of various compounds acting on insects of different orders by inhibiting chitin formation, thereby causing abnormal endocuticular deposition and abortive molting **(Post *et al*. 1974).** Among the inhibitors of chitin synthesis are chlorfluazuron, teflubenzuron, hexaflumuron, novaluron and diflubenzuron. In addition, efforts have been made to develop compounds acting selectively on some insect groups by inhibiting or enhancing the activity of biochemical sites such as respiration (diafenthiuron) and activating the acetylcholine receptor (neonicotinoids) or the GABA receptor (avermectins) (**Horowitz and Ishaaya 2004).** Neonicotinoids interact with nicotinic acetylcholine receptors at the central and peripheral nervous system, resulting in excitation and paralysis, followed by death. Neonicotinoids of potential use in agriculture are imidacloprid, acetamiprid, and thiamethoxam. Microbial insecticides such as *Bacillus thuringiensis* have been reported to provide inadequate control of *S. littoralis* and prime candidates for use in integrated Pest Management Programme (IPM).They have high pathogenicity for target pests. Safe for most non-target organisms, and have good integration with other pest control methods **(Ibrahim *et al*.2010).**

The principle aim of the present study was to evaluate the toxic effect of imidacloprid, Diflubenzuron and Diplel DF against *S. littoralis.*

2. Materials and Methods

2-1−Insect rearing.

The cotton leaf worm, *Spodoptera littoralis* was reared in the laboratory for several generations at room tempratur ranged between 25 - 28 C^o and 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 supplied with a piece of cotton wetted 10% sugar solution as feeding source for the emerged moths and Branches of Tafla (*Nerium oleander* L.) or castor bean leaves were placed as an oviposition site (**El- Defrawi *et al*.**, (**1964**). Egg masses were kept in plastic jars until hatching.

2-2-Insecticides used.

Three insecticides were obtained from Cotton Pesticides Evaluation Department**,** Plant Protection Research Institute, Agricultural Res. Center.

These compounds were evaluated in laboratory tests against the second and fourth instar larvae of *S. littoralis*.

I- Imidacloprid 35% E.C (Adimor) at 30 cm/feddan

II- Diflubenzuron 25% D.F (Dimilin**)** at 100gm/100litre

III- Dipel DF(4.5 % WP) at 200gram / feddan

2-3- Test procedures.

A weighted amount of each of Imidacloprid, Diflubenzuron and Diplel DF was prepared in small doses according to the recommended rates 30cm/feddan for imidacloprid, 100gm/100litre for Diflubenzuron and 200 gm/feddan for Diplel DF starting with 1ml/litre for Imidacloprid and 1gm/litre of both Diflubenzuron and Diplel D.F as stock solution. The castor leaves dipped in only water solution and used as control. The exposure of 2^{nd} and 4^{th} instar larvae to the three compounds depended upon the larval feeding for 48h on treated leaves with these products. After 48h., the treated leaves were replaced by another untreated one and the larvae fed on it until the pupation. Three replicates consists of forty larvae for each concentration of tested series concentrations for any of the three tested compounds for each 2^{nd} or 4^{th} instar larvae were utilized in the treatment and control .Also, the observed malformations were recorded and photographed.

2-4-Statistical analysis:

The total percent of the larval mortality until pupation were recorded and corrected according to the check by using **Abbott formula (Abbott, 1925**). The different biological effects such larval and pupal duration; pupation and adults emergence percent were evaluated at theLC50 values of each of the three tested compound. Also, adult fecundity ,fertility ,longevity ,sex ratio were studied at the these values , The obtained data of the biology were statically 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 freedom degrees**.**

3.Results

3-1-Toxic effect:

Data illustrated in Table (1) showed the toxic effects of the three tested compounds, Imidacloprid, **Diflubenzuron** and Diplel DF against the 2^{nd} and 4^{th} instar larvae of *Spodoptera littoralis* treated by the feeding methods.Imidacloprid was the most toxic one against the 2^{nd} and 4^{th} instar larvae treated with the feeding method. The LC_{50}values were 90 and 170 ppm for the 2^{nd} and 4^{th} instar larvae, respectively. While, Diflubenzuron was the second one, the LC_{50}values were 150 and 200 ppm, respectively. Whereas, Diplel DF was the least one, its LC_{50} values were 270 and 330 ppm for the treated 2^{nd} and 4^{th} instars, respectively.

These results are in agreement with those of **Mink and Luttrell (1989**)who mentioned that diflubenzuron was as effective as commonly used insecticides (pyrethroid, carbamate and organophosphorous and *Bacillus thuringiensis* insecticides) against 3^{rd} and 5^{th} instar larvae of *Spodoptera frugiperda* when mortality observed until the pupation.Also, they reported that pyrethroid, carbamate and organophorous insecticides resulted in higher larval mortality of *S. frugiperda* than *B. thuringiensis* biocides. While, **Fahmy** and **Kandil** (**1989**) found that both diflubenzuron and triflumuron had equitoxic against the cotton leafworm larvae of *S.littoralis*.Whereas, **Mostafa (1998)** recorded that diflubenzuron was approximately as toxic as triflumuron against the larvae of *Agrotis ipsilon*.In converse, **El-said *et al*. (1989)** reported that teflubenzuron was 10times as toxic as diflubenzuron to 4^{th} larval instars of *S.littoralis*.**Also, El- Halim (1993)** recorded insecticidal and the latent effect of Dipel 2x against the 2^{nd} instar larvae of *S. littoralis* fed on a diet containing 64, 192, 320, 5120 or 6400 IU Dipel 2x/ml in the laboratory. Whereas, **Osman and Mahmoud (2009)** mentioned that Dipel 2x, BioFly , Agrin, BioGaurd, Spinosad, Neemix, Mectin and Match provided higher mortality in the first instar larvae of *Spodoptera littoralis* comparing to the third and fifth instar larvae, although Match, Mectin and Spinosad showed also excellent efficacy against third larval stage at all tested concentrations. Also **El-khayat *et al.* (2012)**, reported that the second instar larvae reflected higher level of susceptibility towards all the tested insecticides that included :Insect growth regulators (Nomolt 15% Mimic 24% an Runner 24%); Bio-insecticides, Tracer , XDE and Dipel 2x ;and Organophosphorus

(Chlorpyrifos)than fourth one. They found that LC50 and LC90 values, chlorpyrifos was the most effective insecticide recorded 0.1 and 0.809 ppm for 2nd instar larvae and 0.472 and 6.838 ppm for 4th instar larvae, respectively, while, tebufenozide appeared to be the least effective compound against both tested instars that gave 9.901and 36.447 ppm against 2nd instar, and 65.736 and 1000.775 ppm against the 4th one, respectively. They reported that the rest compounds gave moderate effects in this respect. Also, **Karima (2013**) found that Bt-formulations named Dipel DF, Dipel 2X and Delfin tested against 2nd and 4th instars larvae of *S. littoralis* were highly killed at the initial time, , followed by Agry, Prorcto and Agerin formulations, respectively. She reported that the storage of Bt-formulations reduced their insecticidal activity.

Table (1): Insecticidal activity of Imidacloprid**, Diflubenzuron and Diplel DF at their LC50 values against the 2nd and 4th instar larvae of *S.littoralis***

Treatment	Age							
	2nd instar				4th instar			
	LC_{50} values	Slope function	95% confidence limit		LC_{50} values	Slope function	95% confidence limit	
			Upper	Lower			Upper	Lower
Imidacloprid	**90**	**6.1**	**270**	**30**	**170**	**7.7**	**527**	**55**
Diflubenzuron	**150**	**2.9**	**360**	**62.5**	**200**	**3.7**	**520**	**76.9**
Diplel DF	**270**	**3.4**	**702**	**104**	**330**	**3.1**	**825**	**132**

2. Latent effect of tested compounds on cotton leaf worm

2.1. Larval and pupal duration:

Data presented in Tables (2and3) indicated that the 2nd and 4th larval instars of *S. littoralis* fed on caster oil leaves treated with Imidacloprid, Diflubenzuron and Diplel DF compounds at the LC_{50} level inducing highly significant ($p<0.01$) increase of the larval duration. The effect was more pronounced with the larval treatment of 2nd larval instar with the three tested compounds, it averaged 18.9±2, 18.8± 2.2 and 18± 2.5 days, respectively, as compared with 14.3± 1days of control. While the 4th instar larvae fed on Diflubenzuron gave the highest significant ($p<0.01$) increase in the larval duration to average 16.5± 3.3 days, as compared to 13.2± 0.6days of control. Whereas, the treatment of 4th instar with both Imidacloprid and Diplel DF compounds caused equal significant increased in the larval duration to average 13.9±1 and 14.4±2.6days, respectively, as compared to that of control (13.2days). Treatment of the 2nd and 4th instar larvae of *S. littoralis* with the three compounds at LC_{50} values showed highly significant ($p<0.01$) increase in the pupal duration (Table 2and 3).The effect was more noticeable with the treatment of 2nd instar with the three compounds to average 30.6±2.7, 23±4.8 and 20.2±1.4 days, respectively, as compared to14.4±0.8days of control .Whereas, the 4th instar treated with the three compounds gave significant ($p<0.01$) increase in the pupal duration. Imidacloprid treatment caused a higher prolongation to pupal duration averaged 28.2days, as compared to13.5days of control. While, the larval treatment of 4th instar with Diflubenzuron and Diplel DF compounds increased the pupal duration to average 19.5±4.5 and 15.1±4.1 days, respectively, as compared to that of control (13.5 days). These results are similar to that obtained by **Abd El-Kader *et al.*** (**1995**) who reported that larval and pupal durations of *S.littoralis* were increased due to feeding on I.GRS, Atabron and Alsystin and their combinations. On the contrary. **Ahmed (2004)** mentioned that the larval period was elongated and the pupal period shorted for the new hatched larvae of pink and spiny bollworms (Laboratory strain) treated with the higher concentrations of Spinosad when compared with untreated larvae.

2.2. Pupation and adult emergence:

Data represnted in Tables (2and 3) demonstrated that the treatment of the 2nd and 4th instars larvae of *S.littoralis* with the three tested compounds Imidacloprid, Diflubenzuron and Diplel DF at their LC50s values, caused highly significant ($p<0.01$) reduction of the pupation percentages, as compared to that of control .The 2nd larval instars treated with the Imidacloprid and Diflubenzuron compounds had equal higher effect. The pupation ranged 55% for the second instar larvae treated with both compound, as compared to that of the check (100%).While, the 2nd instar treated with Diplel DF decreased the pupation to 65%, as compared to that of control. Also the treatment of the 4th instar with Imidacloprid, and Diflubenzuron compounds highly significant decreased in the pupation ranged 57-65%, respectively, as compared to control (100%).Whereas, the 4th instar treated with Diplel DF decreased the pupation to 67%, as compared to that of control.

These results are agreement with that obtained by **Abdel-Ghany *et al*. (1985)** who indicated that the treatment of 5th instar larvae of *S.littoralis* with IGRS, methoprene, diflubenzuron and triflumuron (Bay SIR-8514) inhibited the adult emergence. While, **Abo El-Ghar** *et al*.(**2009**) reported that all the tested compounds,Thuringiensin (β-exotoxin of *Bacillus thuringiensis*), abamectin (avermectin B_1) and diflubenzuron, especially abamectin, resulted in a pronounced decrease of pupation in both

susceptible (16–26%) and field (9.4–36.0%) strains of *S. littoralis* compared with the control (78.7 and 70.8%, respectively),also the emergence of adults in the susceptible strain was highly affected by all treatments compared to that in the control. Hence, Aly *et al*. (2011) recorded that the pupation percentage and total adult emergence of 1st and 2nd instar larvae of *S. cretica* treated with *B. thuringiensis* at the LC50 concentrates were was (47 & 92 %) ,(94 & 100%) and (18 & 84 %),(100 & 100%) for treated and untreated, respectively.

2.3. Morphogenetic effects:

Data presented in Tables (2&3) showed that the larval treatment of 2nd and 4th instar of *S. littoralis* with only Diflubenzuron at the LC50s values gave larval malformation reached 5 and 3.3%, respectively, as compared to 0% of that of control. Whereas, the larval treatment of both instar with Imidacloprid and Diplel DF didn't give larval malformation percents. While, the larval treatment of the two instars with the three tested compounds Imidacloprid, Diflubenzuron and Diplel DF at their LC50s values induced the pupal malformations, as compared to the check. While, the 2nd instar treated with Imidacloprid induces the highest percent reached 20%, as compared to 0% pupal malformations of the check. Whereas, the 2nd instar of both Diflubenzuron and Diplel DF induce 5%, as compared to that of control (0%).Whereas, the 4th instar treated with both Imidacloprid and Diflubenzuron induced 5% pupal malformation percent. But, the larval treatment of 4th instar with Diplel DF gave none pupal malformation percent (0%)

With regarded to the adult malformations (Tables 2 & 3), it was found that the larval treatment of 2nd instar with Imidacloprid, Diflubenzuron and Diplel DF at their LC50s values induced the highest percent reached 12.5, 12.1 and 10% of malformed adults as compared to control (0%).Whereas, the larval treatment of 4th instar with the three tested compounds induced 4.8, 7.2 and 7.1%adult malformations, as compared to control.

These results are similar to those obtained by **Mostafa (1989**) indicated that treatment of 4thinstar larvae of *Agrotis ipsilon* with Atabron, Alsystin and Dimilin produced larval and adult malformations. **Abdel El-Hafez *et al.* (2013**) reported that the 2nd and 4th instar larvae of the cotton leafworm, *S. littoralis* treated with bio-product, Spinosad 24SC, Dipel 2x 6.4 WP and Protecto 9.4 Wp mixed with three vegetable oils to enhance the activity and persistence of the bio-products, the treatments increased larval, pupal and adult malformation percents.

Malformations of *S .littoralis* pupae resulting from the larval treatment of 2nd and 4th instars with appeared three tested compounds, Imidacloprid, Diflubenzuron and Diplel DF at their LC50s values appeared as larvae maintained with the old moulting skin in the posterior end of body(Fig.1) or undersized pupae showing body shrinkage and enclosed with the old skin in the middle of the body (Fig.2) or larval-pupal intermediates (Figs.3-5) or pupal-moth intermediates and moth bear weaken wings (Figs.6 ,8 and 7) or it gave moth bear right or left malformed twisting upward or downward wing(Figs.9-13) or malformed moths with various degrees of deformed bodies and wings (Figs14, 15),as compared to that of control pupae and adult.

Table (2): Biological activity of Imidacloprid**, Diflubenzuron and Diplel DF at their LC50 values against the 2nd instar larvae of *S.littoralis*.**

Treatment	Larval Duration (days) ± SD	% of malformed larvae	Pupation%		Pupal duration (days) ± SD	Adult % emergence ±S.D	
			Normal Mean±SD	Malfo		Normal	Malfo
Imidacloprid	18.9±2**	0	55±11**	20	30.6±2.7**	57.1±0.6**	12.5
Diflubenzuron	18.8±2.2**	5	55±8.2**	5	23±4.8**	58±12**	12.1
Diplel DF	18±2.5**	0	65±10**	5	20.2±1.4**	76±17**	10
Control	14.3±1		100		14.4±0.8	100	
F value	202.9		97.040		582.8	559.9	
P value	0.01	0	0.01	0	0.01	0.0004	0
L.S.D.at.05	0.7		10.2		0.7	4.5	
L.S.D.at.01	0.9		18.00		0.9	8.2	

Table (3): Biological activity of, Imidacloprid**, Diflubenzuron and Diplel DF at their LC50 values against the 4th instar larvae of *S.littoralis.***

Treatment	Larval duration days) ± SD	% of malformed larvae	Pupation%		Pupal duration (days) ± SD	Adult % emergence ±S.D	
			Normal Mean±SD	Malfo		Normal	Malfo %
Imidacloprid	13.9±1**	0	65±12**	5	28.2±2.8**	75±7.1**	4.8
Diflubenzuron	16.5±3.3**	3.3	57±7.1**	5	19.5±4.5**	100n.s	7.2
Diplel DF	14.4±2.6**	0	67±2.3**	0	15.1±4.1**	82±25**	7.1
Control	13.2±0.6	0	100	0	13.5±1.1	100	0
F value	18.7		382.8		294.3	92.7	
P value	0.001		0.01		0.0001	0.01	
L.S.D.at.05	0.7		8.4		0.9	5	
L.S.D.at.01	0.9		15.4		1.2	9.1	

enclosed with the old skin in the middle of the body (Fig.2) or larval-pupal intermediates (Figs.3-5) or pupal-moth intermediates and moth bear weaken wings (Figs.6 ,8 and 7) or it gave moth bear right or left malformed twisting upward or downward wing(Figs.9-13) or malformed moths with various degrees of deformed bodies and wings (Figs14, 15),as compared to that of control pupae and adult.

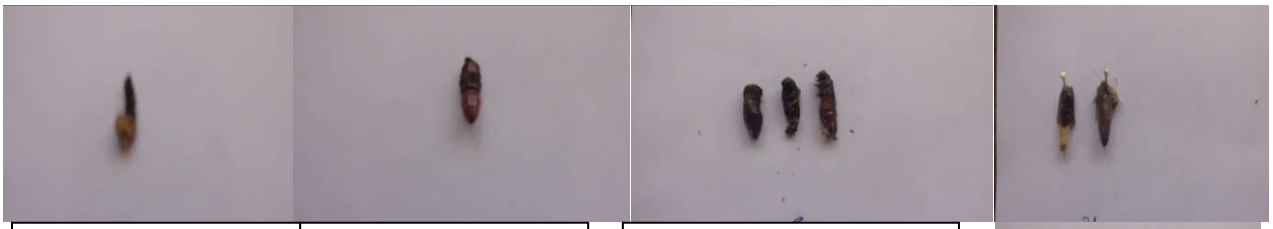

Fig.1) larvae maintained with the old moulting skin around the abdominal capsule

Fig.2) undersized pupae showing body shrinkage and kept with the old skin in the posterior end

(Fig.3-5) larval-pupal intermediates with larval cuticle patches, head capsule and thoracic legs posterior

Fig. 6, 7 and 8) pupal-moth intermediates and moth bear weaken wings.

Fig.9-13) moths bear right or left malformed twisting upward or downward wings.

Fig.14, 15) moths with various degrees of deformed bodies and wings

2.4. Adult fecundity and fertility:

Data presented in Table (4 and 5) indicated that the treatment of both 2nd and 4th instar larvae of *S. littoralis* with the three tested compounds,

Imidacloprid, Diflubenzuron and Diplel DF at their LC50s values highly significantly ($p<0.01$) reduced the adult fecundity. And the 2nd instar larvae treated with both Imidacloprid and Diflubenzuron had the strongest effect in adult fecundity reduction to reach zero, as compared to 558eggs/f of control. While, the larval treatment of the same instar with Diplel DF decreased the adult fecundity to average31eggs/f, as compared to that of control (558eggs/f).Also, the treatment 4th instar larvae with the three tested compounds decreased the adult fecundity to average 27.5, 30and 49.2 eggs/f, respectively, as compared to 488 eggs/f of control. Likewise, the treatment of the second and fourth instars of *S. littoralis* highly significantly ($p<0.01$) reduced the adult fertility, Table (4 and 5). And the 2nd instar larvae treated with both Imidacloprid and Diflubenzuron had the highest effect in eggs fertility to reach zero, as compared to 98.3%of control. Whereas, the larval treatment of the same instar with Diplel DF decreased the eggs fertility to 48.1% reach, as compared to that of control (98.3%).Also, the treatment 4th instar larvae with Imidacloprid had the most potent in eggs fertility reduction to reach zero, as compared to 100% that of control. While, the treatment of the same instar with Diflubenzuron had the next effect in eggs fertility decrease to reach 26.7%, as compared to that of control (100%).Whereas, the 4th instar larvae treated with Diplel DF decreased the eggs fertility to reach 51.8%, as compared to that of control (100%).

These results are in agreement with those obtained by **Pineda *et a*l.** (**2007**) reported that Spinosad and methoxyfenozide reduced in a dose-dependent manner the fecundity and fertility of *S. littoralis* adult when treated oral and residually.**abo- El-Ghar** *et al*. (2009) recorded that the fecundity of moths of *S. littoralis* treated as 4th instar larvae with thuringiensin (β-exotoxin of *Bacillus thuringiensis*), abamectin (avermectin B_1) and diflubenzuron was highly reduced, especially in thuringiensin (65.3–89.0%) and abamectin (57.6–87.4%)treatments compared with that of control. Also, **Abdel** El-**Hafez** *et al.* (**2013**) reported that the 2nd and 4th instar larvae of the cotton leafworm, *S. littoralis* treated with bio-product, Spinosad 24SC, Dipel 2x 6.4 WP and Protecto 9.4 Wp mixed with three vegetable oils to enhance the activity and persistence of the bio-products, the treatments decreased the adult fecundity and eggs fertility, as compared to that of control

2.6. Adult longevity:

Data obtained in Table (4 and 5) showed that the treatment of the second and fourth instars of *S. littoralis* with the three tested compounds highly significantly ($p<0.01$) reduced the adult longevity as compared to that of control. The 2nd and 4th instars treated with Diflubenzuron and Diplel DF at their LC50 values had the highest effect in inducing the shortest adult longevity to average 7.1, 7.6, 7.2 and 7,7.2days, respectively, as compared to13.7 and 11 days, respectively of control**.**Whereas, the 2nd and 4thinstar larvae treated with Imidacloprid decreased the adult longevity to average 8.7 and 8.1 days, respectively, as compared that of control (13.7 and 11days).

These results are in agreement with that obtained by **Radwan *et al*. (1984)** they reported that the lifespan of females of *S. littoralis* treated (at conc.10-200ppm) with I.G.RS, diflubenzuron and triflumuron was significantly shorter that of untreated females. Also, **Abdel El-Hafez *et al.* (2013)** reported that the 2nd and 4th instar larvae of the cotton leafworm, *S. littoralis* treated with bio-product, Spinosad 24SC, Dipel 2x 6.4 WP and Protecto 9.4 Wp mixed with three vegetable oils to enhance the activity and persistence of the bio-products, the treatments decreased the adult longevity, in respect of control.

2.7. Adult sex ratio:

Data obtained in Table (4 and 5) demonstrated that the larval treatment of the second and fourth instars of *S. littoralis* with the three tested compounds shifted the sex ratio of adult males and females, it induced males increase and females decrease, as respect to that of control .The treatment of 2ndinstar larvae with Imidacloprid had the highest effect in this respect, it increased the adult males to reach 57.1%,as compared to 46.7%of that of control, and it decreased the adult females to reach 42.9%,as compared to 53.3% of that of contol.Whereas, the treatment of the 2nd instar with both Diflubenzuron and Diplel DF at their LC50 values had the a similar effect on sex ratio, it induced adult males increase to reach 54.6% ,and decreased the females to reach 45.5%,as compared to 46.7:53.3 of males and females, respectively ,of control. Also, the larval treatment of 4th instar with the three compounds caused males increase and females decrease, Hence the treatment of this instar with Diflubenzuron had the most potent in this respect; it shifted the adult males and females to reach 83.3 and 16.7%, as compared to 50:50% of adult males and females of control. While, the treatment of 4th instar with Diplel DF had the next effect on adult males and females shifting, it reached 57.5:42.5%, respectively, as compared to that of control (50:50%, respectively).Whereas, the same instar larvae treated with the Imidacloprid shifted the adult males and females to reach 54.6:45.5 %, respectively, as compared to that of control.

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 *S. littoralis* Imidacloprid had the highest efficacy against the insect, Imidacloprid is a neonicotinoid compound belonging to the chloronicotinyl insecticide which has gut and contact activities against insects. 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.

Table (4): Biological activity of Imidacloprid**, Diflubenzuron and Diplel DF at their LC50 values against the 2nd instar larvae of *S.littoralis.***

Treatments	Fecundity	Hatching %	Longevity	Adult sex ratio (%)	
	Mean±S.D. (eggs/f)		Mean±S.D (days)	Male	Female
Imidacloprid	0±0**	0	8.7±0.5**	57.1	42.9
Diflubenzuron	0±0**	0	7.1±3.1**	54.6	45.5
Diplel DF	31±1**	48.1	7.6±2.5**	54.6	45.5
Control	558±58	98.3	13.7±1.3	46.7	53.3
F value	269.2		212.4		
P value	0.004		0.01		
L.S.D.at.05	69.0		0.7		
L.S.D.at.01	126.7		1.0		

Table (5): Biological activity of Imidacloprid**, Diflubenzuron and Diplel DF at their LC50 values against the 4th instar larvae of *S.littoralis.***

Treatments	Fecundity	Hatching %	Longevity	Adult sex ratio (%)	
	Mean±S.D. (eggs/f)		Mean±S.D (days)	Male	Female
Imidacloprid	27.5±2.5**	Non-hat	8.1±0.7**	54.6	45.5
Diflubenzuron	30±2.7**	26.7	7±3.1**	83.3	16.7
Diplel DF	49.2±3.7**	51.8	7.2±3.7**	57.5	42.5
Control	488±45	100	11.0±2.8	50	50
F value	232.0		23.829		
P value	0.0047		0.00007		
L.S.D.at.05	63.9		1.1		
L.S.D.at.01	117.3		1.5		

References:

Abbott, W.S. (1925): A method of computing the effectiveness of an insecticide .J.Econ.Entomol. 18: 265-267.

Abdel-Ghanyy-A.A; Negm-S. E.; Saleh, A. A; and A. A. Ghany (1985): Morphological and biological impact of certain insect growth regulators on larvae and pupae of Egyptian cotton leafworm, *Spodoptera littoralis*. J. Agric. Sc., Mansoura Univ.,10:280-291.

Abd El-Hafez, H., Elham, F. A. E. R. and E.M. Mohamed, E.M. (2013): Effect of some vegetable oils in enhancing the potency of bioinsecticides against the cotton leafworm. Egypt. J. Agric. Res., 91 (4), 1361-1383.

Abdel-Kader, M.M.; Shaaban, M.N.; Abdel-Rahman, H.A.; Mosustafa, O.K.; and E.M. Radwan. (1995): Effect of insect growth inhibitors, insecticides their combinations on some biological aspects of *Spodoptera littoralis* . J. Agric. Res., 73.

Abo El-Ghar, G. E. S.; H. S. A. Radwan, Z. A. El-Bermawy and L. T. M. Zidan (2009): Sublethal effects of Avermectin B1, β-Exotoxin of *Bacillus thuringiensis* and Diflubenzuron against cotton leafworm. J. Appl. Ent.Vol. 119, Issue 1-5, pages 309–313.

Ahmed, E. M (2004): New approaches for control of cotton bollworms. D.ph thesis, Faculty of Agric. Cairo Univ.

El-Defrawi, M. F; Toppozada, A.; N. Mansour, and M. Zaid (1964): Toxicological studies on the Egyptian cotton leafworm, *Prodenia litura* I_Susceptibility of different larval instars of Prodenia to insecticides J.Econ. Entomol, 57:591-593.

El Halim, S. M. A. (1996): Bioactivity of Dipel 2X, a commercial preparation of Bacillus thuringiensis against the cotton leafworm Spodoptera littoralis. Egyptian J.of Agric. Res 71(1): 175-183.

EL-Khayat, E. F.; W. M. H.Desuky, M. M. Azab, and M. M.A. Kherd (2012): Toxic impact of some insect growth regulators and biocides in relative to chlorpyrifos to cotton leafworm, *Spodoptera littoralis*. Egypt. J. Agric. Res., 90 (1):55-65.

El-Saidy, M.F.; Auda, and, D. Degheele (1989): Detoxification mechanisms of diflubenzuron and teflubenzuron in the larvae of *Spodoptera littoralis* .Pesticide Biochem. and Physiol. 35:211-222.

Fahmy, H.S.M. and M.A. Kandil (1989): Effect of Diflubenzuron and triflumuron growth regulators on the larvae of the cotton leafworm, *Spodoptera littoralis*. Bull. Ent.Soc.Egypt, Econ.Sfer., 17 pp.169.

Horowitz, A. R., and I. Ishaaya. (2004): Biorational insecticides—Mechanism, selectivity and importance in pest management. In Insect pest management; field and protected crops, ed. A. R. Horowitz and I. Ishaaya, 1–28. Berlin: Springer.

Ibrahim, M. A., G., J.M. Natalya, and B.Lee (2010): Bt. Agenomics and proteomics perspective.Bio eng.Bugs.1 (1):31-51.

Mink, J. S. and R. G. Luttrell, (1989): Mortality of fall armyworm,*Spodoptera frugiperda* eggs, larvae and adults exposed to several insecticides on cotton. J.Econ.Sci. 24(4):563-571.

Mostafa, S.A. (1998): Bioeffecacy of certain insect growth regulators on the black cutworm, *Agrotis ipsilon*.J.Appl.Sci, 13(4).

Osman, A.M. and F. M Mahmoud (2009): Effects of bio-rational insecticides on selected biological aspects of the Egyptian cotton leafworm *Spodoptera littoralis*. J. of Plant Protection Research 49 (2):135-140.

Pineda ,S. M. , G., Smagghe, A.M. Martinez, P.D., Estal , E.V. Viñuela and J. F.Budia (2007): Lethal and sublethal effects of methoxyfenozide and Spinosad on *Spodoptera littoralis* (Lepidoptera: Noctuidae). J Econ Entomol.

Post, L. C., de Jong B. J., and W. R. Vincent. (1974):1-(2, 6-Disubstituted benzoyl)-3-phenylurea insecticides: Inhibitors of chitin synthesis. Pest. Biochem. Physiol. 4:473–83.

Radwan, H.S.A.; Assal, O.M. and M.E. Samy. (1984): Reproductive inhibition activity of certain synthetic pyrethroids and IGRS against the cotton leafworm, *Spodoptera littoralis*.Zeitschrift-fur-Angewandte-Entomologie.97 (2)130-133.

الملخص العربى

النشاط الآبادي للاميداكلوبريد والديميلين والدا يبل دي أف ضد يرقات العمر الثاني والرابع لدودة ورق القطن ألكبري.

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محطة بحوث سدس.مركز البحوث الزراعية . معهد وقاية النباتات . الجيزة. الدقي . مصر

اجريت هذة الدراسة بغرض تقييم التأثير السام لاثنيين من المركبات الحديثة وهما ايميداكلوبريد والد يبل دي أف و منظم النمو الحشري (الدايفلوبنزرون) ضد يرقات العمر الثاني والرابع لسلالة معملية لدودة ورق القطن تحت الظروف المعملية. غذيت يرقات العمر الثاني والرابع لمدة ٤٨ ساعة على ورق خروع تم غمره لمدة ١٥ثانية في سلسلة تركيزات لكل مركب من المركبات الثلاثة المختبرة لتحديد قيم التركيز النصفي لكل مركب. أوضحت النتائج إن مركب الاميداكلوبريد كان اكثر فاعلية ضد كل من العمر الثاني والرابع حيث بلغت قيمة التركيز النصفي القاتل له٩٠ppm و١٧٠ للعمرين الثاني والرابع على التوالي وكان لمركب الديفلوبنزورن التأثير الثاني حيث بلغت قيمة التركيز نصف المميت له ١٥٠ppm و ٢٠٠ للعمرين على الترتيب.بينما جاء مركب الد يبل دي أف بالمرتبة الثالثة حيث بلغت قيمة التركيز نصف المميت له ٢٧٠ ppm و٣٣٠لكل من العمرين على التوالي.تأثرت المعايير البيولوجية لليرقات بعد المعاملة لكل من للعمرين الثاني والرابع بالمركبات الثلاثة. التأثير تنوع مع اختلاف العمر اليرقى والمركب المختبر وبناء على ذلك أدت معاملة العمرين بالمركبات الثلاثة المختبرة إلي خفض نسب التعذير والخروج للحشرة الكاملة وكان لمعاملة العمر الثاني بمركبي الاميداكلوبريد ومنظم النمو الحشري الديفلوبنزورن له التأثير الأقوى في هذا الشأن . بينما معاملة العمر الثاني بالمركبات الثلاثة كانو اكثر فاعلية في زيادة لكل من فترة البقاء اليرقى والعذري ونسبة التشوهات للحشرة الكاملة. بينما معاملة العمرين الثاني والرابع بمنظم النمو الديفلوبنزورن أنتج عنه نسب تشوهات يرقيه. كما إن معاملة العمر الثاني بالاميداكلوبريد كان له التأثير الأكبر في زيادة نسب التشوهات العذرية.بينما المعاملة للعمر الثاني بكل من الاميداكلوبريد والديفلوبنزورن كانو اكثر فاعلية في اضمحلال الخصوبة إلى الصفر مقارنه ٥٥٨ بيضه لكل أنثى للكنترول وأيضا انعدم فقس البيض (صفر%) مقارنة ٩٨,٣% للكنترول.ومن ثم معاملة العمر الثاني والرابع بالديفلوبنزورن والد يبل دي أف كانو اكثر فاعلية في نقص العمر الحشري بالمقارنة بالكنترول.كما إن المعاملة اليرقيه للعمرين الثاني والرابع بالمركبات الثلاثة زودت من نسب الذكور البالغة ونقص نسب الإناث بالمقارنة بالكنترول.وبناء عليه معاملة العمر الثاني بالاميداكلوبريد والعمر الرابع بالديفلوبنزورن كانو اكثر فاعلية في هذا الشأن.