International Journal of Entomology Research
www.entomologyjournals.com
ISSN: 2455-4758
Received: 30-07-2021, Accepted: 15-08-2021, Published: 31-08-2021
Volume 6, Issue 4, 2021, Page No. 254-256

Toxicological study and qualitative analysis of spray droplets for some chemicals and bio-insecticide on the cotton leafworm *Spodoptera littoralis* (Boisd.)

Rehab AA Dar[1], Heba Yousef[1, 2]
[1] Plant Protection Research Institute Agriculture Research Center, Dokki, Giza, Egypt
[2] Department of Chemistry, Faculty of Sciences and Arts, University of Jeddah, Khulais, Jeddah, Saudi Arabia

Abstract
A laboratory experiment to study the effect of four concentrations of *Bacillus thuringiensis*, Deltamethrin, Methomyl, Chlorflurzoran and Profenofos on the 2nd instar larvae of the cotton leafworm *Spodoptera littoralis* (Boisduval). The results showed that Chlorflurzoran and Profenofos Posses the highest toxicity followed by *Bacillus thuringiensis*, Deltamethrin and Methomyl, respectively. The corrected mortality percentages of Chlorflurzoran and Profenofos revealed a 100% mortality after 7, 8 days of exposure to the pesticides, respectively, at the concentration of 0.02% (v/v). The ratio (VMD/N/cm^2) was more developed toward a tendency to the homogeneity of spray spectrum with increasing of the mortality produced by insecticides.

Keywords: *Spodoptera littoralis*, *Bacillus thuringiensis*, deltamethrin, methomyl, chlorflurzoran, profenofos and economy micron ulva

Introduction
The cotton leafworm is a dangerous pest, which infested a wide range of host plants and cause great hazards to them. Much attention directed to compounds disrupts the normal process of insect development. They are known as Insect Growth Regulators (IGR's).
The use of bio-agents like *Bacillus thuringiensis* to control pests has been practiced for a long time. Majority of interest was directed to the type, dosage of insecticides used, while a lesser attention was given to the application methods. (Hindy, 1992) [12] and Dar (2020) [7] recorded a significant variation in the spray deposit due to arrangement of the nozzles, spray technique and the rate of application. The present work aimed to determine the most effective insecticide which controlling the *Spodoptera littoralis*, the number of droplets and droplet sizes produced by Economy Micron Ulva sprayer.

Materials and Methods
Insecticides used

Table 1: Trade names, common names, chemical groups, recommended concentrations and formulations of the insecticides used in this study as follow

Trade names	Common name	Chemical Groups	Recommended conc.'s	Formulations
Dipel-2x	*Bacillus thuringiensis*	Entomopathogenic Bacteria	200 gm/ fed.	6.4 %W.P.
Caprice ®	Chlorflurzoran	IGRs(Chitin synthesis inhibitor)	400 cm^3 / fed.	5%E. C.
Lannate®	Methomyl	Carbamate	800 gm/ fed.	25% W.P.
Kafrothrin®	Deltamethrin	Pyrethroids	350cm^3 / fed.	2.5% E.C.
Sylian®	Profenofos	Organophosphate	750cm^3 / fed.	72% E.C.

Toxicity of the tested insecticides on the 2nd instar larvae of *S. littoralis*
The susceptible strain was reared without contamination with pesticides for more than two years. Four concentrations of aqueous solutions from the tested insecticides; *Bacillus thuringiensis*, Deltamethrin, Methomyl, Chlorflurzoran, Profenofos and used through laboratory bioassays. Castor oil plant leaves were sprayed by each concentration of the five selected compounds at 0.5m spray height by Economy Micrion ULVA sprayer, in the same time, another set of castor oil plant leaves well separate and allowed to overcome excess moisture which leads to insect subjected to Nuclear Polyhedrosis virus (NPV) and molds then introduced to control insects.
After dryness of leaves they introduced to the starved larvae for only 18 hours to ensure a rapid ingestion (Afifi *et al.* 1969).
Then, the larvae were fed on fresh, clean and untreated leaves until pupation. Twenty of 2 nd instars larvae were put in labeled plastic cans (½ Kilo) during the whole period of experiment. Five replicates were made for each concentration of the five tested compounds.

Table 2: Techno-Operational data of the Economy-Micron-ULVA sprayer.

Item	Spining disc ULVA sprayer	Remarks
Type of spraying	Target	Direct spray
Nozzle type	Rotary (spinning disc)	Restrictor
Number of nozzles	1	
Spray tank (L.)	1+10	10 L. spray attached.
Rate of application (L/fed.)	15	
Working speed (Km/h.)	2.4	± 5%
Effective swath width (m.)	1.0	
Flow rate (L/min.)	0.150	Total of the sprayer
Spray height (m.)	0.5	
Productivity * (fed./h.)	0.571	
Rate of performance* (fed./day)	3.04	daily hours =8h.~

* Number of spraying hours = 8 hours daily.

* Calculations of productivity and rate of performance after Hindy (1992).

Calculations and data analysis

a. The mortality rate was recorded daily for 8 days and corrected according Abbott's formula (Abbott, 1925).
b. The obtained data was analyzed by using Proc ANOVA in SAS (Anonymous.2003). Means separation was conducted using LSD in the same statistical program.

Results and Discussion

Table 3: Percentages of larval corrected mortality of *S. littoralis* caused by the *Bacillus thuringiensis* after treatment.

Conc. %	0.02		0.01		0.005		0.0025	
Time (days)	N	M%	N	M%	N	M%	N	M%
Zero	50	-	50	-	50	-	50	-
1days	38	24^{f}	41	18^{f}	43	14^{f}	43	14^{f}
2days	30	40^{e}	35	30^{e}	40	20^{e}	40	20^{e}
3days	20	60^{d}	32	36^{d}	32	36^{d}	35	30^{d}
4days	11	78^{c}	22	56^{c}	27	46^{c}	29	42^{c}
7days	5	90^{b}	11	78^{b}	17	66^{b}	21	58^{b}
8days	1	98^{a}	7	86^{a}	12	76^{a}	18	64^{a}
F value	-	541.8	-	1120	-	406.1	-	473.6
LSD	-	3.84	-	2.52	-	3.77	-	2.91
Significance	-	***	-	***	-	***	-	***

Table 4: Percentages of larval corrected mortality of *S. littoralis* caused by Deltamethrin after treatment.

Conc. %	0.02		0.01		0.005		0.0025	
Time (days)	N	M%	N	M%	N	M%	N	M%
Zero	50	-	50	-	50	-	50	-
1 days	32	36^{f}	40	20^{f}	42	16^{f}	48	4^{f}
2 days	25	50^{e}	34	32^{e}	38	24^{e}	42	16^{e}
3 days	22	56^{d}	32	36^{d}	32	36^{d}	38	24^{d}
4 days	15	70^{c}	24	52^{c}	25	50^{c}	35	30^{c}
7 days	7	86^{b}	13	74^{b}	20	60^{b}	32	36^{b}
8 days	1	98^{a}	7	86^{a}	11	78^{a}	22	56^{a}
F value	-	315.1	-	565	-	2496	-	212.7
LSD	-	3.99	-	3.3	-	1.45	-	3.63
Significance	-	***	-	***	-	***	-	***

Table 5: Percentages of larval corrected mortality of *S. littoralis* caused by Methomyl after treatment.

Conc. %	0.02		0.01		0.005		0.0025	
Time (days)	N	M%	N	M%	N	M%	N	M%
Zero	50	-	50	-	50	-	50	-
1days	44	12^{f}	45	10^{f}	46	8_{f}	46	8^{f}
2days	40	20^{e}	42	16^{e}	43	14^{e}	44	12^{e}
3days	28	44^{d}	30	40^{d}	33	34^{d}	37	26^{d}
4days	22	56^{c}	25	50^{c}	30	40^{c}	35	30^{c}
7days	10	80^{b}	22	56^{b}	26	48^{b}	30	40^{b}
8days	6	88^{a}	15	70^{a}	21	58^{a}	25	50^{a}
F value	-	856.8	-	702.3	-	452	-	560.4
LSD	-	3.25	-	2.72	-	2.81	-	2.01
Significance	-	***	-	***	-	***	-	***

Table 6: Percentages of larval corrected mortality of *S. littoralis* caused by Chlorflurzoran after treatment.

Conc. %	0.02		0.01		0.005		0.0025		Control	
Time (days)	N	M%	N	M%	N	M%	N	M%	N	M%
Zero	50	-	50	-	50	-	50	-	50	-
1 days	36	28^{e}	38	24^{e}	42	16^{f}	45	10^{e}	50	0
2 days	23	54^{d}	27	46^{d}	38	24^{e}	41	18^{d}	50	0
3 days	7	86^{c}	19	62^{c}	33	34^{d}	40	20^{d}	50	0
4 days	5	90^{b}	15	70^{b}	27	46^{c}	30	40^{c}	49	2
7 days	0	100^{a}	4	92^{a}	22	76^{b}	22	58^{b}	48	4
8 days	-	-	2	96^{a}	10	80^{a}	18	64^{a}	48	4
F value	-	101.5	-	376.6	-	561	-	297.7	-	-
LSD	-	2.8	-	4.36	-	3.48	-	3.41	-	-
Significance	-	***	-	***	-	***	-	***	-	***

Table 7: Percentages of larval corrected mortality of *S. littoralis* caused by Profenofos after treatment.

Conc. %	0.02		0.01		0.005		0.0025	
Time (days)	N	M%	N	M%	N	M%	N	M%
Zero	50	-	50	-	50	-	50	-
1 days	10	80^{d}	15	70^{c}	21	58^{c}	35	30^{d}
2 days	2	96^{c}	9	82^{b}	19	62^{b}	31	48^{c}
3 days	2	96^{c}	8	84^{a}	16	68^{a}	27	54^{b}
4 days	1	98^{b}	8	84^{a}	16	68^{a}	27	54^{b}
7 days	1	98^{b}	8	84^{a}	16	68^{a}	27	54^{b}
8 days	0	100^{a}	8	84^{a}	15	70^{a}	20	60^{a}
F value	-	138.5	-	20.22	-	16.8	-	70.97
LSD	-	1.92	-	3.84	-	3.48	-	3.84
Significance	-	***	-	***	-	***	-	***

Conc. % =v⁄v insecticide in water. N=Number of alive larvae M%=Mortality percentages.

As mentioned in Tables (3-7) the used insecticides were evaluated the 2nd instar larvae of *S. littoralis*; corrected mortality percentages of Chlorflurzoran and Profenofos revealed a 100% mortality after 7, 8 days of exposure to the pesticides, respectively at concentration 0.02% (v\v). The corrected mortality of *Bacillus thuringiensis*, Deltamethrin and Methomyl treatments were 98, 98 and 88 % after 8 days, respectively. Our results were in agreement with Bakr *et al* (2013), Dar *et al* (2015) [9], Dar *et al* (2019) [8] and Dar (2020) [7].

Relationship between laboratory spray quality and larval mortality by the Economy Micron Ulva sprayer:

Table (8) A satisfactory coverage was obtained in field experiment on cotton plant, the optimum droplet sizes was agreed with the droplets spectrum which for controlling insects of field crop should be sized between 140 and 200 μm (VMD) with number not less than 30 and 50

droplets/cm^2 distributed homogeneously on the treated target Himel (1969) [10] and (Himel *et al*., 1969) [11] in the optimum droplet size to control the cotton leaf worm in the cotton fields by ground equipment. The usage of Economy Micron Ulva sprayer in order to resemble the spray in field with a number and volume of droplets can be identified. The ratio of [VMD/N/cm^2] (Matthews 1979) [13] was 1.7, 0.94, 0.99, 1.01 and 1.03 when used 0.02% (v/v) concentration of *Bacillus thuringiensis*, Deltamethrin, Methomyl, Chlorflurzoran and Profenofos, respectively. But the ratio was 1.5 for water only. This phenomena was due to the physical properties of the used liquid certainly the ratio between the viscosity and the surface tension into the different concentrations used and the effected on the homogeneity, this result agreed with both (Fraser and Eisenklam, 1956) & (Nordby and Skuteurd, 1975).

Table 8: Qualitative analysis of spray droplets for some chemical and bio-insecticide on *S. littoralis*.

Conc %	0.02			0.01			0.005			0.0025		
Insecticides used	**N/cm^2**	**VMD**	**SQ**	**N/cm^2**	**VMD**	**SQ**	**N/cm^2**	**VMD**	**SQ**	**N/cm^2**	**VMD**	**SQ**
B. thuringiensis	86^{d}	145^{b}	1.7	94^{c}	150^{b}	1.6	99^{d}	151^{c}	1.5	117^{e}	162d	1.4
Deltamethrin	150^{a}	140^{c}	0.94	155^{a}	148^{b}	0.96	160^{a}	155^{b}	0.97	165^{c}	163c	0.99
Methomyl	123^{c}	122^{d}	0.99	139^{b}	142^{c}	1.02	155^{b}	146^{d}	0.94	182^{a}	154e	0.85
Chlorflurzoran	152^{a}	154^{a}	1.01	160^{a}	167^{a}	1.04	155^{b}	165^{a}	1.06	159^{d}	170b	1.06
Profenofos	140^{b}	145^{b}	1.03	145^{b}	151^{b}	1.04	150^{c}	162^{ab}	1.08	170^{b}	173a	1.01
F value	585.9	301.5	-	154.2	47.9	-	413.7	35.4	-	351.8	82.1	-
LSD	3.55	2.15	-	6.68	4.23	-	3.48	4.23	-	4.23	2.57	-
Significance	***	***	-	***	***	-	***	***	-	***	***	-

The spray height is constant ~ 0.5 meter in all treatments
VMD= Volume mean diameter, N/cm^2= Number of droplets/cm^2
VMD/N/cm^2= Spray quality (degree of homogeneity)
Numbers followed by the same letter at the same column are not significantly different at P= 0.05.
***Statistically significant at p<0.05.

The ratio (VMD/N/cm^2) was developed toward a tendency to homogeneity of spray spectrum with increasing of the mortality produced by the insecticide. This results was in agreement with Bakr *et al*. (2004 and 2013), Dar (2020) [7] and Alakhdar *et al* (2021) [3].

Conclusion

The results recommended that Chlorflurzoran, Profenofoshave higher toxicity followed by *Bacillus thuringiensis*, Deltamethrin and Methomyl, respectively. These compounds may be introduced in IPM programs to control the *S. littoralis*. The ratio (VMD/N/cm^2) by Economy Micron Ulva sprayer was developed toward a tendency to homogeneity of spray spectrum with increasing of mortality produced by insecticide.

References

1. Abbott WSA. Method for computing the effectiveness of an insecticide. J. Econ. Entomol,1925:18:265.
2. Anonymous. SAS Statistics and graphics guide, release 9.1. SAS Institute, Cary, North Carolina 27513, USA, 2003.
3. Alakhdar HH, Dar RA, Abd-El Rahman TA. Toxicological evaluation and Residual Analysis of some Acaricides against Two-Spotted Spider Mite *Tetranychus urticae* by Using Certain Ground Spraying Equipment on Cotton and its Intercrops in Egypt. International J. of Entomology Research,2020:6(1):58-67.
4. Bakr RF, Genidy NA, Hindy MA, Dar RA. Biological and qualitative studies of some insecticidal agents on the cotton leafworm under laboratory conditions. J. Egypt. Acad. Soc. Environ. Develop. (A-Entomology),2014:5(2):1-36.
5. Bakr RF, Genidy NA, Hindy MA, Ahmed NS, Dar RA. Biological and qualitative efficiences of some insecticidal agents on the cotton leafworm *S. littoralis* (Boisd.) under laboratory conditions. Egypt. Acad. J. Biolog. Sci,2014:6(2):107-131.
6. Fraser RP, Eisenklum P. Liquid atomization and the drop size of sprays. Trans. Instn. Chem. Engrs,34(4):294-319.
7. Dar RA. The role of NU-Film-17 Spreader in Improvement droplets distribution and increasinginsecticidal activity of certain insecticides on the spiny boll worm *Earias insulana* on cotton plants in Egypt .Egypt. Acad. J. Biolog. Sci., (F-Toxicology & Pest Control),2020:12(1):117-126 .
8. Dar RA, Moustafa HZ, Salem MS. Field studies of different insecticides on cotton seedling pests and their natural enemies by using certain ground spraying equipment at Qalyopia governorate. International J. of Entomology Research,2019:4(4):132-140.
9. Dar RA, Salem MS, Moustafa HZ, Hiekel NS. Evaluation of two ground spraying equipment for controlling spiny bollworm *Earias insulana* (Boisd.) in cotton field J. Plant Prot. and Path., Mansoura Univ,2015:6(2):301- 312.
10. Himel CM. The optimum size for insecticide spray droplets. J. Econ. Entomol,1969:62(4):919-925.
11. Himel CM, Moore AD. Spray droplet size in the control of Spruce, Budworm, Boll weevil, Bollworm and Cabbage looper. J. Econ. Entomol,1969:62(4):916-918.
12. Hindy MA. Qualitative distribution of watery dyed spray produced by certain ground sprayers in cotton. Bull. Ent. Soc., Egypt,1992:19:221-7.
13. Matthews GA. Pesticide application methods. Longman scientific technical book, 1979, 336.
14. Nordby A, Skuterud B. The effect of boom height working pressure and wind speed on spray drift. Weed Res,1975:14(6):385-395.