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Comparative toxicity of some insecticides against army worm, *Spodoptera litura* L. (Lepidoptera: Noctuidae) under laboratory conditions

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Abstract
Cotton (*Gossypium hirsutum* L.) is one of the most impotent cash crops of Pakistan. It is well known fact that it is backbone of Pakistan's economy. *Spodoptera litura* is one of the major insect of cotton that has the potential to reduce yields by 20-80%. Study was designed to check the efficacy of eight insecticides *viz.* Belt (flubendiamide 48SC), Ardent (acrinathrin 5EC), Match (leusenoran 5EC), Larvin (thiodicarb 80DF), Proaxis (Gamma-cyhalothrin 60CS), XDE (spinethylin 12SC), Lorsban (chloropyriphos 40EC) and Timer (emamectin 1.9EC) on fifth instar *Spodoptera litura* larvae. Results indicated that after 3 hours interval Match (lufenuron 5%EC) proved the most effective insecticide against armyworm followed by Lorsban (chloropyrifos 40EC), XDE (spinethylin 12% SC) Ardent (acrinathrin 5%EC), Proaxis (gamma cyhalothrin 40% EC), Timer (emamectin benzoate 1.9%EC), Larvin (thiodicarb 80%DF) and Belt (flubendiamide 48% SC) with LC_{50} values 226.08, 235.7 (140.0-395.46), 240.4 (296.7-194.8), 266.6 (324.3-219.2), 414.3 (529.7-324.6), 432.6 (516.7-332.1), 500.9 (777.8-434.1) and 588.7 (980.7-353.4) ppm, respectively.

Keywords: Mortality, insecticides application, *Spodoptera litura*

1. Introduction

Armyworm, *Spodoptera litura* (Fabricius) (Lepidoptera: Noctuidae) is one of the major insect pests of cotton crops. It is a polyphagous insect [14]. It caused 26-100% yield loss in groundnut [11]. It is variously known as Indian leaf worm, cluster or tobacco caterpillar and common or tobacco cutworm. Under favorable conditions, its population increases in large numbers and moves across field like an army and hence called "Armyworm". In 2003, its outbreak occurred in Pakistan throughout the cotton belt and it devastated the crop [2]. It has about 150 host species including cotton, soyabean, celery, tomato, Chrysanthemum, maize, cauliflower, cabbage and sunflower [30].

The larvae of this pest causes 60 % damage to a number of vegetable and other crops in in India [13]. Cabbage, Tomato, maize, potato, sweet potato, millet, castor bean, rape, cotton, rice, citrus, sorghum and many other vegetables are important host crops of this insect pest [29]. Upto 71% yield loss has been reported in groundnut in the irrigated tracts of Andhra Pardesh, Karnataka and Tamil Nadu, and the southern states of India [5].

Cotton (*Gossypium hirsutum* L.) is one of the most important cash crops of Pakistan. It is well known fact that it is backbone of Pakistan's economy [20]. It has a share of 40-60% in foreign exchange earning [16]. It provides food, feed, fiber and fuel. It sustains millions of people for their livelihood at farms, ginning factories, textile mills, edible oil and soap industries etc. The world production of cotton is about 20 million tones which is dominated by three producers like USA, China and India with a combined share of over 55%. The average seed cotton yield in Pakistan (511 kg/ha) is above the world average but it is still lower than in countries like Australia, USA, Egypt and Turkey. It suffers heavy yield losses due to insect's pests, disease, and weeds.

To control the lepidopterous insect pest, farmers totally relay on insecticides in Pakistan [7]. Indiscriminate use of insecticides created the resistance problems in *S. litura* against different insecticides [26, 2, 25, 33]. It destroyed natural enemies and pollinator's fauna and also created the health and environmental problems [10, 12].

Keeping in view the current problem regarding insecticides resistance and their effectiveness against this pest, present study was planned to find out the toxicity of different insecticides, which are being used against *S. litura,* the pest of economic importance in Pakistan so that an effective insecticide may be selected to control this notorious pest insect.

2. Material and Methods

2.1 Experiment and Methodology

Experiment was carried out under CRD during 2012-13. Fifth instar larvae of armyworm (*Spodoptera litura* L.) were collected from vicinity of Faisalabad and brought to the Laboratory at University of Agriculture, Department of Entomology, Faisalabad for this project. Eight insecticides, viz., Belt (flubendiamide 48SC), Ardent (acrinathrin 5EC), Match (leusenoran 5EC), Larvin (thiodicarb 80DF), Proaxis (Gamma-cyhalothrin 60CS), XDE (spinethylin 12SC), Lorsban (chloropyriphos 40EC) and Timer (emamectin 1.9EC) were used in this experiment and a serial concentration of these insecticides were prepared in acetone. For residual toxicity studies, 5 ml of each insecticidal concentration was added in glass jar with a dropper. After drying the bottles in the air, 10 larvae of armyworm were introduced into each jar (450 ml capacity). A control treatment (Acetone) was also be maintained for comparison of results. The concentrations of all the insecticides used were 1000 ppm, 500 ppm, 250 ppm, 125 ppm. Once a concentration was chosen, the following equation assist in determining the amount of solution added to make the desired concentration. (C1)(V1) = (C2) (V2) Where C1 is the concentration of stock solution; V1 is the volume of stock needed to make the new concentration; C2 is the concentration being prepared; and V2 is the volume of the new concentration. This was replicated three times using completely randomized design [31] and data was recorded after 3, 6, 12 and 24 hours. The jars were placed under control conditions at temperature 25 ± 2^0 C and 65 ± 5% R.H.

2.2 Treatments and Doses

Trade Name	Common Name	Dose
Belt 48SC	flubendiamide	40 ml/acre
Ardent 5EC	Acrinathrin	200ml/acre
Match 5EC	Leufenuron	200 ml/acre
Larvin 80DF	Thiodicarb	200g/acre
Proaxis 60CS	gamma-cyhalothrin	100ml/acre
XDE 12SC	Spinethylin	80ml/acre
Lorsban 40EC	Chloropyriphos	800-100 ml/acre
Timer 1.9EC	Emamectin	200 /acre

2.3 Statistical Analysis

Dose mortality relationship was determined by probit analysis in software M. Stat C [31].

3. Results and Discussion

The result on comparative toxicity of eight different insecticides, viz., emamectin benzoate (Timer 1.9EC), flubendiamide (Belt 48SC), acrinathrin (Ardent 5EC), leufenuron (Match 50EC), thiodicarb (Larvin 80 DF), gamma-cyhalothrin (Proaxis 60CS), spinethylin (XDE 12 EC) and chloropyrifos (Lorsban 40EC) are presented. The results regarding the $LC_{50}$of flubendiamide (Belt 480 SC) against army worm (*Spodoptera litura* L.) by residual glass jar method at different time intervals are presented in Table 1. It is evident from the results that $LC_{50}$was 588.7 ppm after 3 hrs with the slope value 1.06 $\pm$ 0.31. The LC_{50} dropped down to 202.4, 256 and 232 ppm after 6, 12 and 24 hrs, respectively LC_{50} values for gamma cyhalothrin (Proaxis 60CS against army worm by residual glass jar method, treated with different concentrations of insecticide. The LC_{50} was 432.6 ppm after 3 hrs. The LC_{50} dropped down to 239.2ppm after 6 hrs. After 12 and 24 hrs LC_{50} values were 177 and 140-ppm with the slope values 2.56 and 2.81, respectively. LC_{50} values for thiodicarb (Larvin 80 DF) against army worm by residual glass jar method, treated with different concentration of insecticides. The LC_{50} was 266.6 ppm after 3 hrs with the slope value 180. The LC_{50} dropped down to 241, 203 and 191 ppm after 6, 12 and 24 hrs, respectively. LC_{50} values for emamectin benzoate (Timer 1.9 EC) against army worm by residual glass jar method, treated with different concentration of insecticide. LC_{50} was 500.9 ppm after 3 hrs. The LC_{50} dropped down to 409.8, 212.7 and 179.3 ppm after 6, 12 and 24 hrs, respectively with the slope values of 1.68, 1.68 and 2.74 at the same time intervals, respectively. LC_{50} of Lorsban (chloropyrifos 40 EC) against army worm by residual glass jar method, treated with different concentration of insecticide. LC_{50} was 235.7 ppm after 3 hrs. The LC_{50} dropped down to 78.91, 71.58 and 33.04 ppm after 6, 12 and 24 hrs, respectively. LC_{50} of XDE (spinethylin 12%EC) against army worm (*Spodoptera litura* L.) by residual glass jar method, treated with different concentration of insecticide. LC_{50} was 240.4 ppm after 3 hrs. The LC_{50} dropped down to 230.8 ppm after 6 hrs. After 12 and 24 hrs of time intervals LC_{50} values were 208.5 and 191.6 ppm. LC_{50} of Ardent (acrinathrin 5%EC) against army worm by residual glass jar method, treated with different concentrations of insecticide. LC_{50} was 414.3 ppm after 3 hrs. The LC_{50} dropped down to 239.6, 119.6 and 78.91 ppm after 6, 12 and 24 hrs, respectively. LC_{50} of lufenuron (Match 5%EC) against army worm by residual glass jar method, treated with different concentration of insecticide. LC_{50} was high 226 ppm after 3 hrs. The LC_{50} dropped down to 170.9, 164.16 and 128.59 ppm after 6, 12 and 24 hrs, respectively.

The results revealed that time effect was significant on the mortality of insects. After 3 hours interval Match (lufenuron 5%EC) proved the most effective insecticide against armyworm followed by Lorsban (chloropyrifos 40EC), XDE (spinethylin 12% SC) Ardent (acrinathrin 5%EC), Proaxis (gamma cyhalothrin 40% EC), Timer (emamectin benzoate 1.9%EC), Larvin (thiodicarb 80%DF) and Belt (flubendiamide 48% SC) withLC_{50} values 226.08, 235.7 (140.0-395.46), 240.4 (296.7-194.8), 266.6 (324.3-219.2), 414.3 (529.7-324.6), 432.6 (516.7-332.1), 500.9 (777.8-434.1) and 588.7 (980.7-353.4) ppm, respectively. Different scientists across the world reported insecticide resistance in armyworm to different insecticides. Our work on insecticide poses contradiction to [3] who reported emamectin the most effective followed by lufenuron but our results after 24 hours conclusively suggest that chloropyrifos is most effective insecticide against *S. litura* followed by Ardent and lufenuron. The present findings cannot be compared with those of [23] who reported 56-fold resistance to endosulfan, 5-73 fold resistance to malathion, 14.73 fold to pyrethrin, 16.25 fold to lendane and 85.91 fold resistance to carbaryl. [24, 15, 28, 17, 27, 21] tested various insecticides viz., quinalphos, monocrotophos, cypermethrin, abamectin, monosultap, chlorofluazuron, decamethrin, fenvalerate, deltamethrin, alpha-cypermethrin, betacyfluthrin and endosulfanetc for resistance against *S. litura*and reported different resistant folds and their results did not tally with the present findings as of differences in the insecticide used to determine resistance levels against *S. litura* in the present study. Similarly [9, 11, 6] also studied different insecticides to determine their resistance against *S. litura* as those of included in the present study. The findings of [22] can partially be compared with the present findings who studied chloropyriphos in comparison with lambda cyhalothrin, cypermethrin, fenvalerate, fenpropathrin. Methyl parathion, phosmidon, endosulfan. Quinalphos, monocrotophos, malathion, pyrethrin, fenitrothion, lindane, fenthion and dimethoate by determining LC_{50} and reported 0.04612 LD_{50} and proved under intermediate stage towards toxicity against *S. litura* but in the present study chloropyriphos was proved the most effective insecticide for the control of *S. litura*. The present findings can partially be compared with those of [19, 18, 6] who studied chloropyriphos against S. *exigua* and S. *litura*in comparison with various other insecticides and reported similar results as observed in the present findings. Ahmad *et al*. (2005) [5] studied LD50s for emamectin, lufenuron, spinosad and indoxacarb and reported that emamectin proved to be the best effective insecticide to control the 2nd instar larvae of *S. litura* but in the present studies emamectin benzoate (Timer 1.9 EC) with LC_{50} 409.8 proved to be the least effective amongst other insecticides tested. The present findings are in line with those of [1] who studied resistance levels by determining LC_{50} for endosulfan, profenofos, chloropyrifos, thiodicarb, cypermethrin, bifenthrin, lambda-cyhalothrin, indoxacarb and spinosad against *Helicoverpa armigera*.

Table 1: LC_{50} of different insecticides against army worm (*Spodoptera litura* L.) by residual glass jar method at different time intervals.

Insecticides	Time (hrs)	$LC_{50(ppm)}$	SLOPE± SE	Fiducial limit (95%)
flubendiamide (belt 480 SC)	3.0	588.7	1.06 ± 0.31	(980.7-353.4)
	6.0	202.4	1.98 ± 0.35	(269.7-151.8)
	12.0	256.0	2.56 ± 0.42	(225.9-138.9)
	24	232.0	2.32± 0.37	(270.8-167.1)
proaxis (gamma cyhalothrin 60CS)	3.0	432.6	1.80 ± 0.50	(516.7-332.1)
	6.0	239.2	1.98 ± 0.35	(290.9-196.6)
	12.0	177.1	2.56 ± 0.42	(225.9-138.9)
	24	140.5	2.81 ± 0.40	(175.9-120.5)
larvin (thiodicarb 80 DF)	3.0	266.6	1.80 ± 0.50	(324.3-219.2)
	6.0	241.4	1.98 ± 0.35	(290.7-200.5)
	12.0	203.9	2.56 ± 0.42	(247.6-167.9)
	24	191.2	2.81 ± 0.40	(242.7-150.7)
timer (emamectin benzoate 1.9 EC)	3.0	500.9	1.72 ± 0.33	(777.8-434.1)
	6.0	409.8	1.68 ±0.34	(598.5-384.1)
	12.0	212.7	1.68 ± 0.34	(333.4-179.1)
	24	179.3	2.74 ± 0.44	(224.8-142.9)
lorsban (chloropyrifos 40 EC)	3.0	235.7	1.80 ± 0.17	(140.0-395.46)
	6.0	78.91	1.87 ± 0.33	(43.89-141.8)
	12.0	71.58	2.14 ± 0.35	(27.94-183.3)
	24	33.04	2.01 ± 0.34	(10.2-106.5)
XDE (spinethylin 12%EC)	3.0	240.4	2.57 ± 0.38	(296.7-194.8)
	6.0	230.8	2.51 ± 0.38	(286.9-185.7)
	12.0	208.5	2.57 ± 0.40	(260.6-166.9)
	24	191.6	2.23± 0.38	(249.6-147.1)
ardent (acrinathrin 5%EC	3.0	414.3	2.00 ± 0.34	(529.7-324.6)
	6.0	239.6	2.14 ± 0.35	(306.6-187.2)
	12.0	119.6	1.80 ± 0.17	(158.7-90.07)
	24	78.91	1.87 ± 0.33	(43.89-141.8)
match (lufenuron 5%EC)	3.0	226.08	2.86 ± 0.42	(275.10-185.8)
	6.0	170.9	2.86 ± 0.46	(213.98-163.54)
	12.0	164.16	2.56 ± 0.43	(211.94-127.1)
	24	128.59	0.55 ± 1.29	(97.40-3.24)

4. Conclusion

Match (lufenuron 5 % EC) proved the most effective with respect to other treatments. So in future this insecticide will give better results in IPM program to avoid insecticide resistance.

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