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Efficacy of Pyrethroids And New Chemistry Insecticides Against Spodoptera Litura Under Laboratory Conditions

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Abstract

Agricultural crops are affected through various insect pests and needed mixtures of insecticide application to manage the pest population. An experimental study was conducted during 2019 to check the efficacy of three new chemistry and two pyrethroids insecticides single as well as in mixtures against third instar larvae of Spodoptera litura. The experiment was performed under laboratory using leaf dip method. LC50 of emamectin benzoate, deltamethrin, chlorfluazuron, flubendamide and bifenthrin were 0.82 and 0.09, 342 and 132, 264 and72.4, 2.91 and 0.30 and 365 and 72 ppm, respectively after 24 and 48 hours of exposure. The new chemistry insecticides were most effective while pyrethroids lest due to their high LC50 values. Among all tested insecticides, flubendamide and emamectin benzoate were more toxic insecticides having less LC50 values as compared to chlorfluazuron. The mixtures of deltamethrin with emamectin-benzoate, flubendamide and chlorfluazuron were antagonistic. Bifenthrin was showed more toxicity with flubendamide and emamectin. The study revealed that pyrethroids can give best control against insect pests like S. litura when mixed with new chemistry insecticides.

Keywords: Armyworm; Pyrethroids; New chemistries; Multan; Pakistan.

Introduction:

The excessive use of insecticides is harmful for human and environment. The new chemistry insecticides are safer, effective, less toxic for human and environment (Korrat et al., 2012). The combine applications of new chemistry insecticides are the best strategy to control the resistance population of insect pests (Attique et al., 2006) and help to enhance the crop production (Ahmad et al., 2009). The combine application of different insecticides can improve the toxicity of insecticides and give better insect pests control like Spodoptera litura under both (laboratory as well as field) conditions (Bhatti et al., 2013).

The various groups of insecticides have laboriously been applied for the management of various agricultural pests especially S. litura (Tong et al., 2013). S. litura has developed resistance (Kranthi et al., 2002) against several groups of insecticides (Saeed et al., 2012) like carbamate, organophosphates, chlorinated hydrocarbons and pyrethroids (Ahmad et al., 2007a; Maqsood et al., 2017).

This pest has developed resistance against the new chemistry insecticides (Ahmad et al., 2008) such as quinalphos, lindane, fipronil, monocrotophos, endosulfon, avermectins, spinosad, benzene hexachloride and indoxacarb (Shankarganesh et al., 2012). In Pakistan, in excess of 34 insecticides belonging to various groups have been applied against several agricultural insect pests including Spodoptera litura (Saleem et al., 2008).

Intensively and improper use of insecticides is the major reason of insecticides resistance (Ahmad and Arif, 2010) and difficulties in pest management. Pest population and resistance can manage through the application of different insecticide mixtures (Dittrich et al., 1990) with different mode of action (Ahmad et al., 2008, 2009).

Materials and Methods:

Study area:

The present study was conducted at Rearing Laboratory of Muhammad Nawaz Shareef University of Agriculture Multan during 2019. The alone and combine efficacy of new chemistry and pyrethroids insecticides at their LC50 ratios was evaluated against S. litura.

Collection of insects:

Larvae of S. litura were collected randomly from different farmer fields of cauliflower and cotton at district Multan (30.2° N, 71.4° E and 123-meter-high above sea level.

Maintenance of insect culture:

The collected larvae were brought to Rearing Laboratory for rearing purpose. Larvae were reared in plastic petri-plates at natural diet (cabbage). The larvae were converted into pupae, pupae collected on daily basis and placed into plastic containers. The emerged adults were shifted into adult rearing cages and placed a nap liner for egg lying purpose and collected on daily basis. The honey solution was made as artificial diet for adult rearing. Cotton ball soaked with 10% honey solution and placed into cage as diet. The culture was maintained up to seven generations at 26±2°C temperature and 60±10% relative humidity with 14:10 photoperiod.

Tested insecticides:

The lethal effects of following insecticides; Bifenthrin (Talstar 10EC, FMC Pakistan), Deltamethrin (Decis Super 10.5 EC, Bayer Crop Science, Pakistan), Chlorfluazuron (chlorfluazuron 5EC, 4B Pesticides, Pakistan), Flubendamide (Belt 48SC, Bayer Crop Science, Pakistan) and Emamectin benzoate (Proclaim 1.9EC, Syngenta Pakistan) were studied against larvae of S. litura. The stock solution was prepared in 50 ml of distilled water with 5-6 serial solutions. For mixture preparation, further insecticides were added in stock solutions at their particular LC50 and further dilutions.

Bioassay:

Insecticides efficacy was evaluated against newly 3rd instar larvae of seven generation by using leaf-dip method. Petri-dishes of 5 cm diameter were purchased from nearby market and lined with moist filter paper. The newly emerged and insecticides free cabbage leaves were collected from farmer field, cut into 5 cm discs dips for 5-10 seconds in the stock solution and treated leaves were air-dried on paper towel for an hour to remove the extra water. Before treatment, leaves were washed with running water and then dried for an hour to remove the water. Treated leaves were placed in petri-dishes and five newly emerged third instar larvae were released per petri dish with the help of camel hairbrush. Mortality data were recorded after 24, 48 and 72 hours for single insecticide while 48 hours for mixtures.

Statistical analysis:

Recorded data was statistically analyzed by using POLO-PC for their respective fiducial limits, LC50, LC90 and slope ± SE based on mortality data at 5% probability level. By using combination index, toxicity of insecticide mixtures was calculated (Ahmad et al., 2009).

Results:

The toxicity of chlorfluazuron, flubendamide, deltamethrin, emamectin-benzoate and bifenthrin was checked against third instars larvae of S. litura. The insecticides were applied singly and as well as in mixture form. LC50 values and lethal effects of insecticides were observed at 48 hours interval.
LC50s of deltamethrin, bifenthrin and Emamectin after 24 hours were 342, 365 and 0.82 ppm, respectively while after 48 hours 132, 72 and 0.09 ppm, respectively. LC90s of deltamethrin, bifenthrin and Emamectin after 24 hours (Table 1) were 2970, 4879 and 16.9 ppm, respectively while 617, 900 and 0.91 ppm, respectively after 48 hours (Table 2). C50s and LC90s of Flubendamide were 2.91, 0.30, 0.34 and 91.4, 2.67, 2.14 ppm, respectively after 24, 48 and 72 hours.

LC50s of insect growth regulator, chlorfluazuron was 264, 72.4 and 53.0 ppm after 24, 48 and 72 hours, respectively (Table 1) whereas chlorfluazuron showed LC90s of 2477, 450 and 251 ppm after 24, 48 and 72 hours, respectively (Table 1,2,3). During the study, it was observed that emamectin benzoate was the most toxic insecticide against S. litura larvae. LC50s and LC90s of emamectin were 0.08, 0.37 and 0.09, 0.91 ppm after 48 and 72 hours, respectively.

Mixture of deltamethrin with chlorfluazuron was showed antagonistic effects. LC50s and LC90s of deltamethrin and chlorfluazuron mixture were 304, 86.9 and 3814, 1082 ppm after 24 and 48 hours, respectively (Table 4).
Deltamethrin with emamectin mixture was showed LC50s of 412 and 57.5 ppm and LC90s of 3513 and 1182 ppm after 24 and 48 hours, respectively. Mixture of deltamethrin with emamectin showed antagonistic effect with combination index (CI) of 1.03.
The LC50s of mixture of bifenthrin and chlorfluazuron were 570 and 203 after 24 and 48 hours, respectively while LC90s of mixture of bifenthrin and chlorfluazuron were 7461 and 12451 ppm, respectively. The high antagonistic effect was recorded by the mixture of bifenthrin and chlorfluazuron with CI of 4.60 (Table 4).

The synergistic effects with combination index value of 0.33 was found by the combine application of bifenthrin and emamectin benzoate. The study resulted that combine application of emamectin benzoate and flubendamide, chlorfluazuron and deltamethrin were antagonistic while bifenthrin with chlorfluazuron also presented antagonistic effect but synergistic with flubendamide and emamectin benzoate.

Insecticides	Time	LC50 (FL at 95%)	LC90 (FL at 95%)	Slope ± SE	df	χ^2	CR
Bifenthrin	24	365 (225-850)	4879(1672-50290)	1.15±0.23	4	0.50	390
Deltamethrin	24	342 (232-709)	2970(1299-23939)	1.35±0.38	3	0.96	399
Chlorfluazuron	24	264 (191-439)	2477(1195-9091)	1.33±0.27	4	1.26	317
Flubendamide	24	2.91(1.41-17.9)	91.4(15.9-18977)	0.90 ±0.23	4	0.30	3.21
Emamectin	24	0.82(0.52-2.19)	16.9(5.06-219)	0.99 ±0.23	4	0.50	1.01

Table 1: Toxicity of single application of new insecticides and pyrethroids against 3rd instars larvae of S. litura after 24 hours.

Insecticides	Time	LC50 (FL at 95%)	LC90 (FL at 95%)	Slope ± SE	df	χ^2	CR
Bifenthrin	48	72 (48.9-109)	900(444-3297)	1.15±0.22	4	0.50	924
Deltamethrin	48	132 (111-180)	617(399-1320)	1.94±0.30	3	2.45	1672
Chlorfluazuron	48	72.4 (54.1-96.7)	450(299-820)	1.61±0.29	4	1.89	920
Flubendamide	48	0.30(0.29-0.60)	2.67(1.63-6.99)	1.44 ±0.22	4	0.70	4.70
Emamectin	48	0.09(0.09-0.18)	0.91(0.55-2.14)	1.23 ±0.19	4	0.90	1.00

Table 2: Toxicity of single new insecticide and pyrethroids against 3rd instars larvae of Spodoptera litura after 48 hours.

Insecticides	Time	LC50 (FL at 95%)	LC90 (FL at 95%)	Slope ± SE	df	χ^2	CR
Bifenthrin	72	65.8 (42.1-95.2)	705(379-2229)	1.25±0.21	4	1.05	1098
Deltamethrin	72	101(77-130)	412(285-776)	2.09±0.31	3	1.36	1670
Chlorfluazuron	72	53.0 (43.6-65.9)	251(180-403)	1.99±0.22	4	2.98	870
Flubendamide	72	0.34(0.26-0.43)	2.14(1.29-4.69)	1.59 ±0.22	4	0.70	5.33
Emamectin	72	0.08(0.08-0.08)	0.37(0.24-0.55)	1.74±0.23	4	2.00	1.01

Note: CR = comparative ratio divided by the least value at each time interval for LC50 values

Table 3: Toxicity of single new insecticide and pyrethroids against 3rd instars larvae of Spodoptera litura after 72 hours.

Insecticides	Time	LC50 (FL at 95%)	LC90 (FL at 95%)	Slope ± SE	df	χ^2	CI
Mixtures							
Bifenthrin +	24	570 (312-2006)	7461 (2070-18331)	1.14±0.25	4	2.72	-
Chlorfluazuron	48	203 (110-719)	12451 (2093-3357)	0.82±0.19	4	3.10	4.60
Bifenthrin +	24	91.1 (30.7-3433)	6140 (394-1296)	0.80±0.26	4	1.13	–
Flubendamide	48	17.9 (9.77-34.3)	421 (125-9056)	0.91±0.19	4	0.53	0.48
Bifenthrin +	24	51.3 (23-343)	1550 (375-3021)	0.85±0.21	4	2.85	-
Emamectin	48	11.1 (7.56-18.5)	133 (47-568)	1.21±0.21	4	2.99	0.33
Deltamethrin +	24	312 (172-944)	3513 (1139-6443)	1.17±0.24	4	1.96	-
Chlorfluazuron	48	96.9 (46.5-249)	1182 (331-5075)	1.17±0.21	4	5.17	1.03
Deltamethrin +	24	385 (136-27610)	65517 (3550-0.00)	0.57±0.19	4	1.73	-
Flubendamide	48	127 (58.6-595)	13867(1519-4325)	0.63±0.19	4	1.72	2.60
Deltamethrin +	24	412 (204-2147)	8825 (1680-4311)	1.00±0.23	4	3.86	-
Emamectin	48	57.5 (33.5-110.3)	399 (190-3525)	1.46±0.22	4	5.36	1.15

Note: CI = combination index at 48 hours interval for insecticide mixtures

Table 4: Toxicity of new chemistry and pyrethroids insecticides mixtures against 3rd instars larvae of Spodoptera litura.

Discussion:

There are various control strategies have been practiced by farmers to control insect pests. The insecticides belong to different groups are used excessively to manage the pest population at both laboratory and field conditions to improve the crop production. Pyrethroids are the largest group of insecticide which have been used for control of agricultural insect pests such as S. litura (Wang et al., 1994; Biradar et al., 2001). Insecticides are mixed with each other and apply against various insect pests such as mixture of triazophas and deltamethrin used against vegetables and cotton pests.

Cypermethrin is the widely used pyrethroid with chlorpyrifos and profenofos (Ahmad et al., 2009). These have been used for the management of several chewing insect pests such as Plutella xylostella, S. litura (Ramzan et al., 2019), Pectinophora gossypiella and Helicoverpa armigera (Martin et al., 2003; Attique et al., 2006). The continuous application or exposure of these mixtures can cause several problems like health and pollution (Ahmad and Mehmood, 2015). The effectiveness of the insecticides can decrease which resulted in resistance development.

Deltamethrin and bifenthrin mixed with ethion, have some potentiating response to control field population of insect pests such as S. litura (Ahmad, 2008, 2009; Ahmad et al., 2009). During the study, bifenthrin was proved most effective when mixed with flubendamide and emamectin benzoate insecticides. Our study results were in line with the findings of earlier researchers (Attique et al., 2006) they reported that emamectin benzoate shown synergistic effect when mixed with bifenthrin apply against P. xylostella. It may be due to excessive exposure of insecticides under field conditions. There was observed an antagonistic effect between chlorfluazuron, spinoteram with fenpropathrin insecticides against S. litura while proved an effective control of Spodoptera littoralis. The antagonistic effect may be due to high dose of insecticides that suppress the effect of each other. Our findings are similar to the findings of Abdel-Hafeez and Mohamed, (2009).

In the current study, all insecticides tested against 3rd instar larvae of Spodoptera litura were toxic and gave high larval mortality. Among all the tested insecticides, emamectin was proved best insecticide against pest control.

Emamectin was proved effective in both cases like singly and in mixture with other insecticides. Our study findings are in agreement with other researcher observations (Razaq et al., 2005). Our findings will provide informative about judicially use of insecticides to the farmers and researchers (Attique et al., 2006; El-Aswad 2007). Another study was conducted to check the efficacy of combine application of insecticides against second and fourth larval instars of cotton leafworm, Spodoptera littoralis under field conditions. The study resulted feroban was the most toxic insecticide while engeo least toxic among tested insecticides (Abd El-Mageed and Shalaby, 2011). The current study resulted that combine application of insecticides can prove best control against insect pests.

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