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Research Article

Biological Parameters of Armyworm, *Spodoptera litura* and Toxicity of Three Insecticides against 3rd Instars Larvae under Laboratory Conditions

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ABSTRACT

Armyworm, Spodoptera litura is major threat to agricultural and horticultural crops all over the world. Biological parameters of Armyworm, Spodoptera litura and toxicity of different insecticides against 2nd instar larvae on cabbage were conducted in Faisalabad during 2019. The total developmental period from egg to adult was 31 days. The incubation period and percent viability of eggs on cabbage was 3 days and 90%, respectively. The weight of full-grown larva and pupa was 1000 and 300 mg, respectively. The highest adult emergence was recorded 90% on cabbage. Among tested insecticides, emamectin benzoate was found more toxic followed by lufenuron and chlorpyrifos. The significant difference was recorded in lethal time and lethal concentration values. LT_{50} values revealed that chlorpyrifos was recorded more effective followed by emamectin benzoate and lufenuron and required less time to kill 50% 2nd instar larvae. The study informations will be fruitful in pest management.

Keywords: *Spodoptera litura, Biology, Cabbage, Caterpillar, Insecticide efficacy, Time and dose mortality.*

INTRODUCTION

Armyworm, *Spodoptera litura* (Lepidoptera: Noctuidae) is destructive pest of agricultural and horticultural crops (Qin et al., 2004; & Murtaza et al., 2019) all over the world (Ahmad et al., 2007a). It mostly found in tropical and subtropical regions of the world including Pakistan (CAB, 2003).

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As polyphagous pest, feed on more than 50 genera of plants belonging to different families (Malvaceae, Solanaceae, Fabaceae) (Han et al., 2008; & Stewart et al., 2002) and cause economic losses (Ahmad et al., 2007; & Ramzan et al., 2019c) of various crops such as cotton, maize, cabbage, berseem, potato, tomato and okra (Maree et al., 1999; & Ramzan et al., 2019b). Several management strategies (cultural, botanical, biological, chemicals) are applied to control this serious pest in Pakistan. Chemicals like insecticides practices are mostly adopted by farmers at national and international level against this pest to minimize the crop losses (Adamski et al., 2009; Alvarez et al., 2009a, b; & Ramzan et al., 2019a). The application of insecticides can manage the pest population and also cause harmful impact on environment (Antwi & Peterson, 2009) and natural enemies. The use of same group of insecticides against a pest can cause resistance and become problem to control that pest. The information about insecticides group, time of spray application, time mortality and effective dose of insecticides against target pests are play important role in insect pest management. The conventional insecticides are commonly applied against *S. litura* all over the world but satisfactory results not obtain against this pest (Kim et al., 1998). The resistance to new chemistry and conventional insecticides have been reported (Perez et al., 2002; & Ahmad et al., 2009). Time mortality and effective dose against this serious pest are very important in the selection of best insecticides. For this purpose, the current study was conducted to check the efficacy of commonly used insecticides against *S. litura* under controlled conditions.

MATERIALS AND METHODS

Collection and stock culture/rearing of insect

The egg batches and different instars of *S. litura* were collected from different cabbage fields in Faisalabad and reared into plastic containers on cabbage leaves. The leaves of cabbage were collected from unsprayed fields and wash with flowing water, air dried and given to larvae for feeding. The rearing of pest was carried out in rearing laboratory at Department of Entomology, University of Agriculture, Faisalabad during 2019. New cabbage leaves were given to larvae on daily basis till the pupation. Pupae were kept into separate plastic containers for adult emergence and six pairs of emerged adults shifted into adult rearing cages for egg lying. In rearing cage, cotton balls soaked in 10% honey solution were placed as adult diet. Tissue paper was hanged inside the rearing cage for female oviposition. Eggs were collected from paper on daily basis and 30 eggs used for biology study. One egg was placed per petri dish and biological parameters (Egg-Adult) recorded on cabbage leaves. Third instar larvae of F_2 generations were tested to check insecticide toxicity.

Insecticides

The following insecticides were tested; lufenuron (Match® 05EC, Syngenta, Pakistan), emamectin benzoate (Proclaim® 1.9EC, Syngenta, Pakistan) and chlorpyrifos (Lorsban® 40EC; Dow Agro Sciences, Pakistan).

Bioassays

Equal size and age or newly moult second instars larvae were randomly selected from stock culture. Cabbage leaves were collected from nearby unsprayed cabbage fields, washed with water and air dried for half an hour. A standard leaf disc bioassay method was used to perform the bioassay (Ahmad et al., 2009). Stock solution of each tested insecticide was prepared with different concentrations. Leaf discs were dipped in a test solution for 10 second. After fixed time of discs dipping (10 s), discs were placed into tissue paper to absorb the extra liquid and allowed to dry for half an hour. Discs were dipped only in distilled water and considered as control. After 30 minutes, discs were placed individually in petri dishes. There were eight replications of each treatment and each replicate containing five second instars. The treated petri dishes were kept at temperature of 28±2°C and 10:14 dark and light. Larval mortality and time mortality data were recorded after 48, 72 and 12 hours of post treatment, respectively.

Statistical analysis

Mortality data was corrected by Abbott's formula using POLO-PC software. The differentiation of significance levels was determined by Fiducial limits at 95% interval.

RESULTS AND DISCUSSION

Armyworm, *S. litura* is serious pest of various crops in the globe and cause economic crop losses throughout the globe. The several management strategies had been adopted to control this pest and every strategy prove best option to manage this. Chemical method is extensively used against insect pests all over the world but caused harmful impact on human and animals health. The use of insecticides can give quick mortality of serious pests and helpful in crop production or yield (Ramzan et al., 2019c). Different mode of action insecticides (contact, stomach and fumigants) had applied against fields and laboratories populations of sucking as well as chewing insect pests like *Spodoptera* species in Pakistan. The nerve poison insecticides were applied against second instars larvae of current pest.

In the current study, different insecticides that commonly use against various insect pests were tested to check their toxicity against 2nd instars larvae. The dose and time mortalities of each insecticide against *S. litura* was also determined. All tested insecticides were proved effective and give maximum mortalities of tested (2nd instars larvae of *S. litura*).

The insecticides caused concentration–dependent mortality in larvae and lethal concentrations and slopes were significantly different to each other (Table 1).

Table 1: Dose-mortality data for tested insecticides against second instar larvae of *Spodoptera litura*

Insecticide	LC50 (mg/l)	FL at 95% level[a]	Slope±SE[b]	X
Emamectin benzoate	0.010	0.090–0.001	1.69±0.99	1.62
Chlorpyrifos	166	110–245	1.49±0.25	6.30
Lufenuron	0.76	0.29–0.96	1.99±0.89	3.78

Note: [a]FL=Fiducial limits at 95% confidence level and [b]SE= Standard error

LC_{50} values of emamectin benzoate and lufenuron were not only significant from each other but also from chlorpyrifos. The similar results had been discussed by early scientists (Saeed et al., 2012). Among tested insecticides, emamectin benzoate was found more toxic followed by lufenuron and chlorpyrifos.

LT_{50} values showed that 50% insect population was died by cypermethrin within short time followed by lufenuron and chlorpyrifos (Table 1). It was observed that the mortalities percentage (%age) increase with increase in insecticides concentration and time. The current study findings and El-Sheikh (2015) and Comparative Toxicity of Insecticides against Two Important Insect Pests of Cauliflower Crop Imran et al. (2017) findings are in line with each other about toxicity of emamectin benzoate. No mortality was recorded in control where discs only dipped in water. Ahmad et al. (2006) have reported the similar findings of Emamectin benzoate about time and dose mortality of larvae. Insecticides can delay the pupal formation and increase the larval duration. The adult longevity and emergence can also decrease by the application of insecticides (Saeed et al., 2012).

Table 2: Time-mortality data for tested insecticides against second instar larvae of *Spodoptera litura* at their respective LC50

Insecticide	LC50 (mg/l)	FL at 95% level[a]	Slope±SE[b]	X
Emamectin benzoate	26.0	23.2–8.9	4.23±0.38	1.49
Chlorpyrifos	14.7	9.54–22.3	1.75±0.16	8.77
Lufenuron	32.3	20.8–56.5	2.54±0.23	16.1

Note: [a]FL=Fiducial limits at 95% confidence level and [b]SE= Standard error

The excessive application of Emamectin benzoate can cause resistance to pest (Shad et al., 2010). The physiological process like moulting can disturb by the application of lufenuron which require more time to show toxicity and kill 50% population (Smagghe & Degheele, 1994). The biological parameters such as incubation period, larval growth and development can also affected through insecticides application (Clarke & Fleischer, 2003; & Adamski et al., 2009). Sabri et al. (2017) had conducted a study to check the sublethal effect of different biorational insecticides such as lufenuron, emamectin benzoate, methoxyfenozide and indoxacarb against *S. litura* and reported that methoxyfenozide found more toxic insecticide. Our results are contradicting to their findings.

The biological parameters of *S. litura* were recorded on cabbage. The study revealed that incubation period and total duration of larvae were 3 days and 21.7 days, respectively. The percentage of egg hatchability on cabbage was 90% while 92% reported by Kumar and Bhattacharya (2019). The study findings about incubation period were similar to finings of early scientists who reported 2.7-3.9 days (Tuan et al., 2015; & Ashwini et al., 2016). Shakya et al. (2015) had reported 3-5 days on tomato plant. The later instar feed the cabbage vigorously and consume its whole leaf within short period of time. The maximum weight of last instar larva was 1000 mg on cabbage. Tuan et al. (2015) had showed the similar findings about weight of larvae. The total pupal period was 4 days which is in line with previous studies (Shahout et al., 2011) while Yadav et al. (2014) had reported 10 days.

%age of adult emergence, male and female longevity were 87%, 3.45 days and 3.83 days, respectively. These are in line with previous study findings (Pramod, 2013). while many previous researchers had reported 7-8 days (Ravi et al., 2015; & Ashwini et al., 2016). The difference in findings is due to various reasons such as environment (Shahout et al., 2011). The total life cycle of *S. litura* from egg to adult was 31 days. Our observations are in line with the early researchers findings (Yadav et al., 2014) who reported 21-30 days on cabbage.

CONCLUSION

The study concluded that biological parameters are helpful in timely management of insect pests. The tested insecticides are important to maintain the pest population below economic injury level. These are safer insecticides with effective pest control.

Conflict of interest

Authors declare no conflict of interest.

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