Article

Effect of Biolep®, Permethrin and Hexaflumuron on mortality of cotton bollworm, *Helicoverpa armigera* (Noctuidae: Lepidoptera)

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Abstract

Cotton bollworm, *Helicoverpa armigera* is a major pest in cotton and one of the most polyphagous and cosmopolitan pest species of several crops such as cotton, pulses and vegetables in Asia. Lethal effects of Biolep®**,** Permethrin and Hexaflumuron belong to three different groups of insecticides were compared on larval stages of *H. armigera*. The trial was laid out in Randomized Complete Block Design (RCBD) with four treatments including a control and replicated thrice. Our results shown three insecticides, Biolep®**,** Permethrin and Hexaflumuron had significant difference in larval population mortality of *H. armigera*. After 3rd day Biolep® caused maximum mortality that was 39 larvae. Permethrin and Hexaflumuron caused 29 and 31 larval mortality after 3rd day, respectively. Generally, the number of mortality decreased and the maximum rate of mortality in 12th day was 7 larvae that obtained by using Hexaflumuron. Our results showed that the Hexaflumuron was persistent in comparison with other insecticides. Biolep® registered above 75% (average 77) reduction in number of larvae on the basis of post-spray data, followed by 68% and 70% each by Permethrin and Hexaflumuron, respectively.

Keywords Cotton bollworm; *Helicoverpa armigera*; Permethrin; Hexaflumuron; Biolep®.

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1 Introduction

Cotton bollworm, *Helicoverpa armigera* (Noctuidae: Lepidoptera) is one of the serious pests of several crops such as cotton, pulses and vegetables in Asia (Sharma et al., 2005).This pest is very polyphagous and causes an estimated loss of US $ 2 billion on different crops worldwide (Fitt, 1991). Currently, the most efforts on the control of this pest are on the insecticide application, and it has developed high levels of resistance to insecticides (Kranthi et al., 2002).

Different methods, including application of chemical and microbial insecticides, are used to prevent the damage induced by this pest. Microbial control of agricultural and health-related insect pests has been considered as an alternative to synthetic insecticides. Microbial agents are generally highly specific against target insect pests, thus facilitating the survival of beneficial insects in treated crops (Lacey et al., 2001).

Bacillus thuringiensis (Bt) is a rod-shaped, gram-positive, spore-forming, crystal-liferous bacterium which occurs naturally in soil, water and grain dust (Lambert and Peferoen, 1992). Bt was first isolated from lepidopteran larvae and is naturally present in both live and dead insects (Damgaard et al., 1997). The insecticidal activity of Bt is the most important feature of this organism and it is active against more than 150 pest species, including Cotton bollworm, *H. armigera* (Aronson et al., 1986). The insecticidal activity of Bt is primarily due to certain proteins that are synthesised in abundance during sporulation and form crystals that consist of one or more proteins known as Cry or d-endotoxins. The toxins are in the inclusions as inactive protoxins that are solubilised in the alkaline environment of the insect gut and activated by gut proteases. They exhibit a variety of biological actions including cytolytic, hemolytic, in addition to entomocidal activities (Bravo et al., 2004).

In this study we compared lethal effects of Biolep®**,** Permethrin and Hexaflumuron belong to three different group of insecticides (Biolep is a water dispersible powder formulation of *B. thuringiensis* var. *Kurstaki*; Permethrin is a common synthetic chemical belongs to the family of synthetic chemicals called pyrethroids and functions as a neurotoxin; Hexaflumuron is an insect growth regulator that interferes with insects chitin synthesis) on larval stages of *H. armigera*.

2 Materials and Methods

2.1 Location and insects

The study was conducted during 2013 and 2014 at field condition in Mazrae Nemooneh agricultural research station (Aq Qala, Golestan province, North of Iran) (Coordinates: 37°00′50″N 54°27′18″E) (Darvishzadeh et al., 2014). During September and October, the period in which cotton (Golestan cultivar) produces squares, flowers, and first bolls, the experiment was carried out on *H. armigera* larvae of different instars.

2.2 Insecticides

The following insecticides were used: Biolep® (SC formulation of *Bacillus thuringiensis* var. *kurstaki*) (Nature Biotechnology Company (Biorun), SC, 10^8 CFU/ml), Permethrin (Mahan Co., EC 15 %), Hexaflumuron (Mahan Co., EC 15 %).

2.3 Bioassay

The trial was laid out in Randomized Complete Block Design (RCBD) with four treatments including a control and replicated thrice. Plot size was 20 m^2 with row to row and plant to plant distance were 80 and 20 cm, respectively. Three insecticides viz., *B. thuringiensis*, Permethrin and Hexaflumuron at 1500 ppm were in water solution. The control plots were sprayed with water only. Numbers of *H. armigera* larval mortality were counted from whole plants of each treatment plot after 3, 5, 7 and 12 days of the insecticides application. The mean larval mortality (%) of each treatment were compared using Duncan's multiple range test after One Way ANOVA at $\alpha = 5\%$.

2.4 Statistical analysis

Mortality numbers were calculated by the Abbott correction formula for natural mortality in the untreated control (Abbott, 1925). The log dosage-probit response line was obtained with the Probit analysis (Polo-PC 1987). One way ANOVA (analysis of variance) data analysis performed followed by Duncan multiple range test when significant differences were found at $P = 0.05$ using the SPSS 22.0 statistical package.

3 Results

Our results shown three insecticides, Biolep®, Permethrin and Hexaflumuron had significant difference in larval population mortality of *H. armigera*. After 3rd day Biolep® caused maximum mortality that was 39 larvae. Permethrin and Hexaflumuron caused 29 and 31 larval mortality after 3rd day, respectively (Tab. 1). Generally, the number of mortality decreased and the maximum rate of mortality in 12th day was 7 larvae that obtained by using Hexaflumuron. Our results showed that the Hexaflumuron was persistent in comparison with other insecticides (Table 1).

Table 1 Mean mortality of *H. armigera* larvae exposed to different insecticides application (rep= 3).

Treatments	Post-spray mortality (mean ± SE)				
	3rd day	5th day	7th day	9th day	12th day
Biolep®	39±1.09	31±0.98	11±0.74	4±0.13	2±0.09
Permethrin	29±0.89	19±0.87	14±0.64	5±0.15	3±0.10
Hexaflumuron	31±1.03	19±0.74	15±0.44	11±0.25	7±0.21

Mortality number of larval stage of *H. armigera* exposed to insecticides application shown in figure1. These figure shows there are significant differences between the different insecticides used in time periods. Biolep® decreased mortality number more than other insecticides after whole treatment times (Fig. 1).

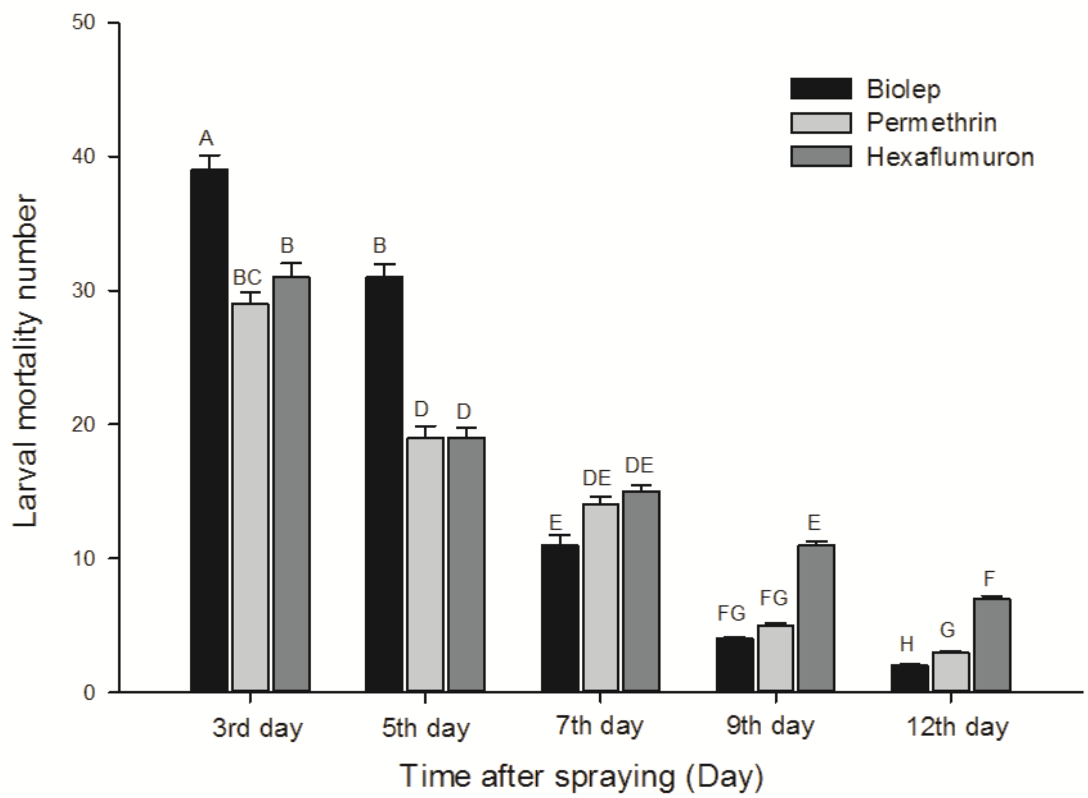

Fig. 1 Mortality number of larval stage of *H. armigera* exposed to different insecticides application (rep= 3) (Different letters over columns indicate significant differences according to Duncan test at α= 0.05; Columns with the same letter are not significantly different; Vertical bars indicate standard error (±)).

Biolep® registered above 75% (average 77) reduction in number of larvae on the basis of post-spray data, followed by 68% and 70% each by Permethrin and Hexaflumuron, respectively (Fig. 2).

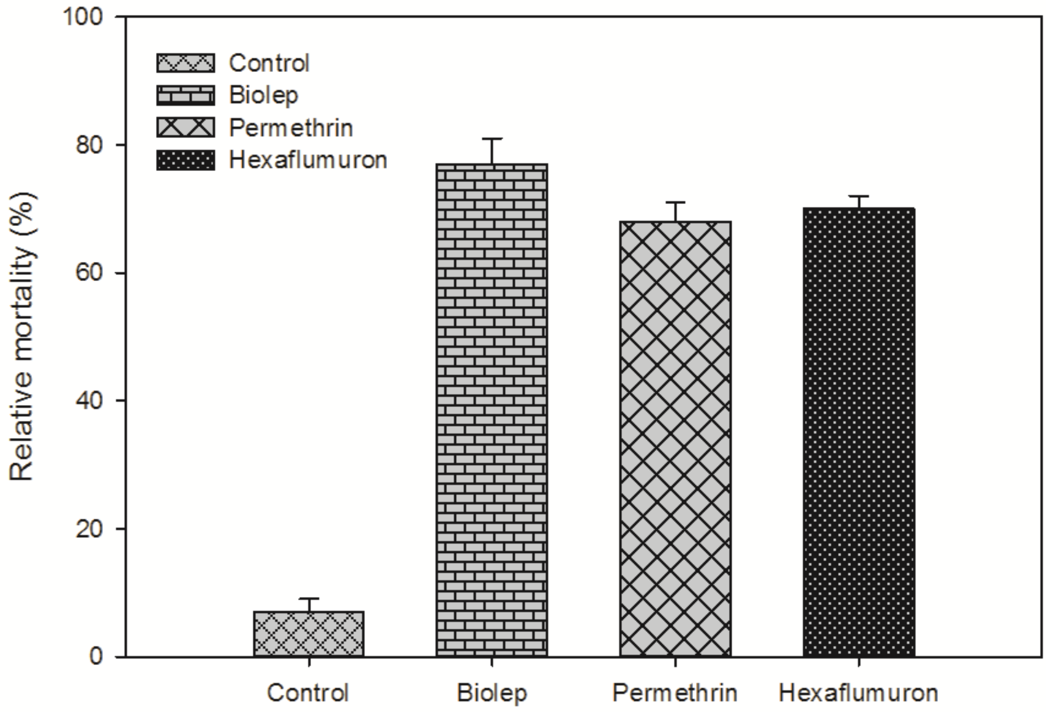

Fig. 2 Mortality% of larval stage of *H. armigera* exposed to different insecticides application.

4 Discussion

This study indicated that the Biolep® is more effective than other pesticides used in control of cotton bollworm. Biolep® is a new microbial class of insecticides with a new mode of action and is registered for use against a wide variety of caterpillars including *H. armigera* larvae (Arshad et al., 2009). Beneficial insects such as assassin bug, damsel bug, lacewing larvae, spiders, predacious mites and wasps (Pollinators and Parasitic) are not significantly affected by residues of Biolep®. The main target for Bt toxins is insect midgut (Knowels, 1994). One option to reduce the insecticide use on cotton is the exploitation of transgenic Bt cotton as a component of integrated pest management programs (Gore et al., 2001). Edge et al. (2001) reported that the integration of transgenic cotton with Bt as an IPM component has many benefits like reduced use of broad-spectrum insecticides, increased control of target pests, reduced production cost, increased yield and better opportunity for biological control. Bt cotton containing Cry1Ac has had lethal effect against *H. armigera* (Arshad et al., 2009; Wan et al., 2005). Transgenic crops may perform differently under different ecological conditions and cropping systems, so there is need for researchers to conduct and layout field trials to study the impact of available Bt cotton varieties on target pests for the long-term implementation of transgenic crops.

Finally, we suggest that other researchers study the synergistic effects of simultaneously application of Biolep® and other conventional insecticides on *H. armigera* to indicate best integration of pesticides for control of this pest.

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