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EFFICACY OF *BACILLUS THURINGIENSIS* (BERLINER) ALONE AND IN COMBINATION WITH ENDOSULFAN AGAINST ARCTIID PEST

MD. ASLAM KHAN
Biology Department, Faculty of Science, Jazan University, Jazan, Saudi Arabia
Email : mdaslam30@gmail.com

ABSTRACT

The available isolates of *B. thuringiensis* were evaluated for their efficacy against the Bihar having caterpillar both alone and in combination with a synthetic insecticide endosulfan. Lowest LC_{50} was noticed in case of *Btk* HD-73 and highest in case of *Btk* path-1. In ascending order LC_{50} values were as *Btk* HD-73, *Bt sotto*, *Bt aizawai, Bt* N1C1, *Btk* HD-1, *Bt thuringiensis*, Dipel, *Bt entomocidus*, *Bt galleriae* and *Btk* Path-1. The lowest LC_{90} was found in case of *Bt sotto* whereas, lowest LC_{95} and LC_{99} were recorded in case of *Bt* N1C1. Twenty four hours after treatment the highest larval mortality, 86.67 per cent, was observed in case of endosulfan, 0.07 with Dipel, 0.075 per cent. However, eight days after treatment mixture of endosulfan with Dipel at 0.035 and 0.03 per cent, respectively caused 96.67 per cent larval mortality.

Key words: LC value, *Spilarctia obliqua, B. thuringiensis*

INTRODUCTION

In agriculture billions of dollars are spent each year on insect pest management worldwide. Despite this expenditure, up to 40 per cent of a crop can be lost to insect damage, particularly in developing countries (Oerke, 2006). In order to feed the projected nine billion people by 2050, farmers must increase their cereal yield by at least 40 per cent (Maxmen, 2013). Over the last five decades chemical insecticides have been the backbone of insect control. Negative impacts of chemical pesticides are increasingly becoming a concern, underlining the need for development of alternative eco-friendly pest control methods.

Biological control however, not as rapid as the chemicals, but is practically more feasible and sustainable than chemical cure (McClintock *et al.,* 2000). The aim of biological control is to reduce pest population below the economic threshold. Use of entomopathogen as biological control agents of crop pests has been recognized as a valuable tool for pest suppression (Rosell *et al.,* 2008). *B. thuringiensis* is the most widely used commercially successful entomopathogen in different forms. Thousands of toxicogenic strains of *B. thuringiensis* exist and each strain produces its own unique insecticidal crystal protein. Depending upon the subspecies and strains of the bacterium, *B. thuringiensis* is pathogenic to a number of major insect orders. Lepidopteran pests can effectively be controlled by *B. thuringiensis* (Nethravathi *et al.,* 2010). Combination of insecticides and *B. thuringiensis* has also been tried to limit the population of lepidopteran pests (Khan *et al.,* 2010). In the present study different *B. thuringiensis* isolates alone and in combination with insecticides have been evaluated against *Spilarctia obliqua* (Walker) (Lepidoptera: Arctiidae), a polyphagous pest, causing severe damage to agricultural as well as horticultural crops all over India.

MATERIALS AND METHODS

Larvae of *S. obliqua* were collected from Aligarh, UP from castor plants and reared in laboratory at Division of Entomology, IARI, New Delhi, till adult emergence. Pairs of emerged adult were caged in jars with 10 per cent sucrose solution. For egg laying vertical strips of rough paper were kept inside jar. Disinfected eggs were kept on blotting paper for hatching. Washed castor leaves were provided to newly hatched larvae at 28 ± 1^{0}C and 75 ± 5 per cent relative humidity. *B. thuringiensis* subsp. *galleriae, sotto, entomocidus, thuringiensis, aizawai,* strains Path-1, HD-1, HD-73, untypified strain N1C1 and commercial formulation Dipel were used in the study. Multiplication of pathogens was done with standard practices and spore-crystal complex was recovered by Dulmage (1970) procedure. Bioassays were conducted in 15 x 20cm plastic jars adopting leaf dip method. Following microbial concentrations, 0.02, 0.04, 0.06, 0.08, 0.10, 0.12 per cent were prepared using Pearson's square method. Third instar larvae, starved for two hours were allowed to feed on the treated leaves for 24 hours, thereafter fresh food was provided to them. Larval mortality was recorded after every 24 hours till treated larvae surviving or control larvae pupated. There were three replications for each treatment with twenty larvae per replication. A comparison of LC values for different isolates was made. Efficacy of Dipel in combination with endosulfan was evaluated separately. The larval mortality was recorded at an interval of two, four, eight, and ten days after treatment.

RESULTS AND DISCUSSION

Bioassays were done separately with each of five *B. thuringiensis* subsp., four strains and one commercial formulation to determine the bioefficacy of each microbial pathogen against third instar larvae of *S. obliqua.* Data reveal the lowest LC_{50} value in case of *Btk* HD-73 and highest in case of *Btk* path-1. However, lowest LC_{90} value was found in case of *Bt sotto* and highest for *Btk* path-1. Highest LC_{95} value was also found in case of *Bt* path-1 and lowest in case of *Bt* N1C1. The highest LC_{99} value was found in case of *Bt galleriae;* whereas, lowest in case of *Bt* N1C1. LC_{50} value, in ascending order, for different subspp/strains were as *Btk* HD-73, *Bt sotto*, *Bt aizawai, Bt* N1C1, *Btk* HD-1, *Bt thuringiensis*, Dipel, *Bt entomocidus*, *Bt galleriae* and finally *Btk* Path-1. However, the trend in values, LC_{90}, LC_{95} and LC_{99} was found to change. The lowest LC_{90} value was found in case of *Bt sotto* whereas, lowest LC_{95} and LC_{99} in case of *Bt* N1C1 (Table 1). The present findings are in full agreement with Karim *et al.,* (1999) who observed a wide range of LC_{50} among local *B. thuringiensis* isolates against *Scirpophaga incertulas* (Walker) and *Cnaphalocrosis medinalis* (Guenee). Comparison of LC values for *S. obliqua* larvae has also been made by Khan (2015). He noticed greater LC_{50} for larval population collected from IARI, New Delhi fields. Studies show that *B. thuringiensis* subsp. *kurstaki* is the most potent variety of *B. thuringiensis* against the lepidopteran pests (Dias *et al*., 1999). In the present study too, subsp. *kurstaki* of *B. thuringiensis* either in the form of *Btk* HD-73 or *Btk* HD-1 proved superior in comparison to other subspp/strains used in the study.

Table 1. LC values of *B. thuringiensis isolates* against Aligarh population of *S. obliqua*

Treatments	Df	Regression equation Y	LC_{50}	LC_{90}	LC_{95}	LC_{99}
Btk Path-1	6	Y=0.054692 +2.429116x	0.108604	0.36597	0.51642	0.98519
Bt galleriae	6	Y=0.416125 +2.296786x	0.099032	0.35791	0.51517	1.02006
Bt sotto	6	Y=0.980157 +2.360628x	0.050451	0.17611	0.25100	0.48790
Bt entomocidus	6	Y=0.289855 +2.694356x	0.091899	0.27477	0.37481	0.67098
Bt thuringiensis	6	Y=0.373476 +2.445002x	0.078026	0.26086	0.36728	0.69773
Bt aizawai	6	Y=1.096880 +2.266524x	0.052732	0.19387	0.28042	0.56033
Btk HD-1	6	Y=0.325172 +2.534473x	0.069903	0.22396	0.31154	0.57858
Btk HD-73	6	Y=1.936403 +1.904415x	0.040615	0.19127	0.29676	0.67641
Bt N1C1	6	Y=0.582855 +2.526614x	0.056008	0.18009	0.25077	0.46662
Dipel	5	Y=0.223811 +2.717466x	0.083620	0.24770	0.33699	0.60030

Table 2. Efficacy of Dipel with endosulfan against *S. obliqua* larvae.

Treatments	Average per cent larval mortality at different intervals (days)			
	1	4	8	10
Endosulfan 0.07%	85.00 (67.21)	96.67 (79.49)	98.33 (82.57)	0.0042 (0.3713)
Endosulfan 0.035%	35.00 (36.27)	45.00 (42.13)	63.33 (52.73)	0.0042 (0.3713)
Dipel 0.075%	6.67 (14.97)	51.67 (45.96)	80.00 (63.43)	0.0042 (0.3713)
Dipel 0.03%	0.0042 (0.3713)	40.00 (39.23)	68.33 (55.75)	0.0042 (0.3713)
Endosulfan 0.07% + Dipel 0.075%	86.67 (68.59)	98.33 (82.57)	100.00 (90.00)	0.0042 (0.3713)
Endosulfan 0.035% + Dipel 0.075%	46.67 (43.09)	88.33 (70.02)	98.33 (82.57)	0.0042 (0.3713)
Endosulfan 0.07% + Dipel 0.03%	85.00 (67.21)	96.67 (79.49)	98.33 (82.57)	0.0042 (0.3713)
Endosulfan 0.035% + Dipel 0.03%	43.33 (41.17)	78.33 (62.26)	96.67 (79.49)	0.0042 (0.3713)
Control	0.0042 (0.3713)	0.0042 (0.3713)	0.0042 (0.3713)	0.0042 (0.3713)
SEm±	2.807444	3.840611	4.599582	–
CD at 5%	5.772106	7.896296	9.45674	–
CD at 1%	7.801888	10.67306	12.78224	–

*Figures in parenthesis are angular transformed values.

All the tested concentrations of endosulfan alone and in combination with Dipel yielded statistically significant larval mortality of *S. obliqua* over control at 5 and 1 per cent levels of significance. Twenty four hours after the treatment the highest larval mortality (86.67 per cent) was observed in case of endosulfan, 0.07 with Dipel, 0.075 per cent; whereas, Dipel alone at 0.030 and 0.075 per cent concentration registered 0.00 and 6.67 per cent larval mortality, respectively. Four days after treatment endosulfan at 0.07 with Dipel at 0.075 per cent registered 98.33 per cent larval mortality; whereas, Dipel alone at 0.030 and 0.075 per cent caused 40.00 and 51.67 per cent mortality, respectively. Eight days after treatment mixture of endosulfan and Dipel at 0.035 and 0.03 per cent, respectively caused 96.67 per cent larval mortality; however, endosulfan and Dipel at 0.07 and 0.075 per cent, respectively registered 100 per cent larval mortality (Table 2). The average mortality in different treatments varied from 63.33 to 100.00 per cent, on 8th day after treatment. On the basis of forgoing results it can be concluded that endosulfan with Dipel at 0.035 and 0.03 per cent, respectively, proved to be the most suitable combination against the larvae of *S. obliqua*. Rao and Singh (2003) also noticed that synthetic insecticides in combination with bio-pesticides show moderate effects on pest damage as well as on predator's populations, which are at par with sole bio-pesticide treatment.

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Note : This paper has been accepted on account of the fact that the work was done before ban of Endosulfan.