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Synergistic Effect of Neem Based Bio pesticide and *Bacillus thuringiensis* Formulation on Feeding Behaviour and Mortality of *Spodoptera litura*

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A B S T R A C T

An investigation was undertaken to identify synergism in efficacy of Neem Based Biopesticide (Econeem Plus®) and *Bacillus thuringiensis* formulation (Delfin®) against *Spodoptera litura*. Mortality was recorded at 1, 3, 5, 7, 10 and 15 days after treatment of 3rd instar larvae of *Spodoptera litura*. Combined application of Delfin and Econeem Plus resulted in 96% mortality over control as against 80% and 88% mortality respectively in individual treatments of Econeem Plus and Delfin. Similar trends were observed on Antifeedant index (86.3%) and growth inhibition (99.4%) by combined application of these products. Combination of Delfin® and Econeem Plus® was found to have more effect for control of *Spodoptera litura*.

Introduction

The caterpillar, *Spodoptera litura* (Lepidoptera: Noctuidae) is a polyphagous pest with high mobility and reproductive capacity. This pest is one of the most important insect pathogens in the world today and widely distributed throughout tropical and temperate Asia, Australia and Pacific islands (Mohammad Monobrullah and Uma Shankar, 2008). *Spodoptera litura* (Fab.) devastates a large host range of more than 120 host plants (Ramana *et al.*, 1988). Indiscriminate use of chemical insecticides to control this pest has resulted in resistance to chemical insecticides, resurgence and deleterious effects to environment and non-target organisms. In recent years microbial insecticides have become a viable alternative to control lepidopteran pests particularly *S. litura.* Biopesticides have the potential to help in the management of these pests as safe alternatives to synthetic insecticides (Schmutterer, 1995; Lowery *et al.*, 1993; Basedow *et al.*, 2002; Elshafie and Basedow, 2003).

Bacillus thuringiensis (Bt) is a gram-positive bacterium, stands out representing approximately 95% of microorganisms used in biological control of agricultural pests in different cultures, which accounts for 1.3 per cent of total pesticides (Ramanujam *et al.*, 2014). Besides the economic aspect and the safety to human health, this bacterium is the most promising for production of bio-pesticides associated with environmental preservation. The research worldwide revealed that, thousands of isolates were collected from various sources and tested for their efficacy against different insect pests. But very few isolates were found specific to lepidopteran pests such as *Spodoptera litura* which is a polyphagous pest with multiple generations in a year. Hence, identifying a bio-product based on active ingredients of Bt is highly useful to avoid problems like environmental pollution, pesticide residues, development of resistance to insecticides, resurgence of secondary pests etc. The bacteria *Bacillus thuringiensis* accounting for 1-2% of the global insecticide market (Lambert and Peferoen, 1992). Quantification of the toxicity by insect bioassays is the only way to assess the potency of a strain for pest control. In this context, the present study was conducted to evaluate efficacy of *Bacillus thuringiensis* formulation (Delfin), Neem Biopesticide (Econeem Plus) and their combination for effective management of *Spodoptera litura.*

Materials and Methods

The influence of treating castor leaf with Econeem plus, Delfin, Delfin+Econeem Plus® on larval growth, feeding behavior and mortality of *Spodoptera litura* larvae were compared with control.

The required numbers of 3rd instar larvae of *Spodoptera litura* were obtained from cultures maintained in lab and preconditioned for 24 hours. The larvae were weighed and transferred into sterilized petriplates, which contained moist filter paper. Surface sterilized castor leaf discs were cut in to 50 mm diameter using a leaf perforator. The leaf discs were dipped in the test solutions prepared as per the protocol for 1 minute and air dried. Untreated control received only distilled water. After the leaf discs were dried, they were transferred into the respective petriplates. The treated leaves were fed to the insects for two days and there after insects were fed on untreated leaves until pupation stage or death. Each treatment was replicated five times with five insects per replicate. The test parameters such as Growth Inhibition, Antifeeding index and Mortality were estimated as per the standard procedures.

Mortality

The observations on mortality were recorded up to 15 days after treatment (DAT), at the intervals of 1, 3, 5, 7, 10 & 15 days. The larvae that did not show any activity when probed with the brush were considered as dead. The corrected mortality was calculated using the following formula.

Percent mortality =

$$\frac{\text{Mortality (\%) in treatment} - \text{Mortality (\%) in control}}{100 - \text{Mortality (\%) in control}} \times 100$$

Antifeedant index

The treated leaves were removed from the petri plates after 2 days of treatment and scanned using a scanner. The area fed was calculated by graphical method.

The Antifeedant Index (AFI) was calculated by using the following formula

$$\frac{\text{Area consumed in control} - \text{Area consumed in treatment}}{\text{Area consumed in control} + \text{Area consumed in treatment}} \times 100$$

Growth Inhibition of larva

The observations on growth inhibition of larvae were taken on 2, 5, 7 Days after Treatment (DAT) by weighing the larvae.

The Growth Inhibition (GI %) was calculated by using the following formula.

$$\frac{\text{Mean of difference in weight in control - Mean of difference in weight in treatment}}{\text{Mean of difference in weight in control}} \times 100$$

Results and Discussion

Out of five larvae used per replication, the average mortality of *Spodoptera litua* after one day of treatment was 0.60 in Econeem Plus, 0.80 in Delfin and 1.20 in the treatment with combination of Delfin and Econeem Plus®. Similar mortality trend was observed in the treatments after 3, 5, 7 and 10 days of imposing the treatments. At all stages of observation Delfin + Econeem Plus® treatment indicated high larval mortality followed by standalone Delfin and Econeem Plus treatment.

After 15 days of treatment, Delfin+Econeem Plus® showed maximum mortality of 96%. Whereas, Delfin exhibited 88% mortality followed by Econeem Plus as 80% mortality over control (Table 1, Figure 1).

Table.1 Mean number of dead *Spodoptera litura* larvae in response to treatments with Delfin, Econeem and their combinations

Tr.no	Treatment Details	Mean number of dead *Spodoptera litura* larvae						
		1 DAT	3 DAT	5 DAT	7 DAT	10 DAT	15 DAT	% Mortality over Control
T1	Econeem Plus®	0.60 (1.02)	1.00 (1.16)	2.60 (1.75)	3.60 (2.02)	4.00 (2.10)	4.00 (2.12)	80.00
T2	Delfin	0.80 (1.12)	1.60 (1.38)	3.20 (1.92)	4.20 (2.17)	4.20 (2.17)	4.40 (2.21)	88.00
T3	Delfin + Econeem Plus®	1.20 (1.30)	2.80 (1.81)	3.60 (2.02)	4.60 (2.26)	4.60 (2.26)	4.80 (2.30)	96.00
T4	Control	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	-
CD (0.05)		0.381	0.626	0.209	0.247	0.324	0.211	

Table.2 The influence of Delfin, Econeem Plus and Delfin+Econeem Plus combination on Anti feedant effect on *Spodoptera litura* larvae

Tr. No.	Treatment details	Antifeedant Index (%)
T1	Econeem Plus®	52.6
T2	Delfin	70.7
T3	Delfin + Econeem Plus®	86.3
T4	Control	-

Table.3 The Anti-feedant influence of Delfin, Econeem Plus and Delfin+Econeem Plus on *Spodoptera litura* larvae

Tr. No.	Treatment details	Growth Inhibition (%)		
		2 DAT	5 DAT	7 DAT
T1	Econeem Plus®	78.8	90.6	95.6
T2	Delfin	81.4	93.2	98.3
T3	Delfin + Econeem Plus®	82.3	94.5	99.4
T4	Control	0.0	0.0	0.0

Fig.1 Percent Mortality of larvae of *spodoptera litura* in response to treatments with Econeem Plus and Delfin+Econeem Plus

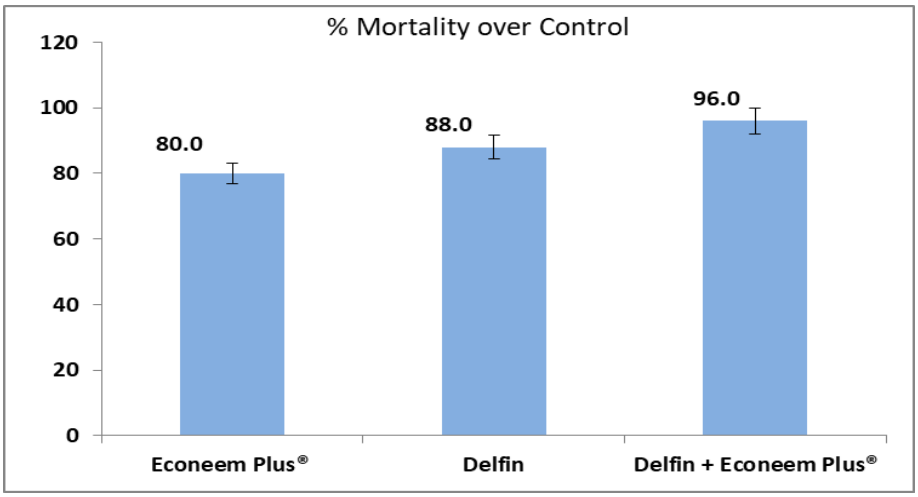


Fig.2 Antifeedant index (%)

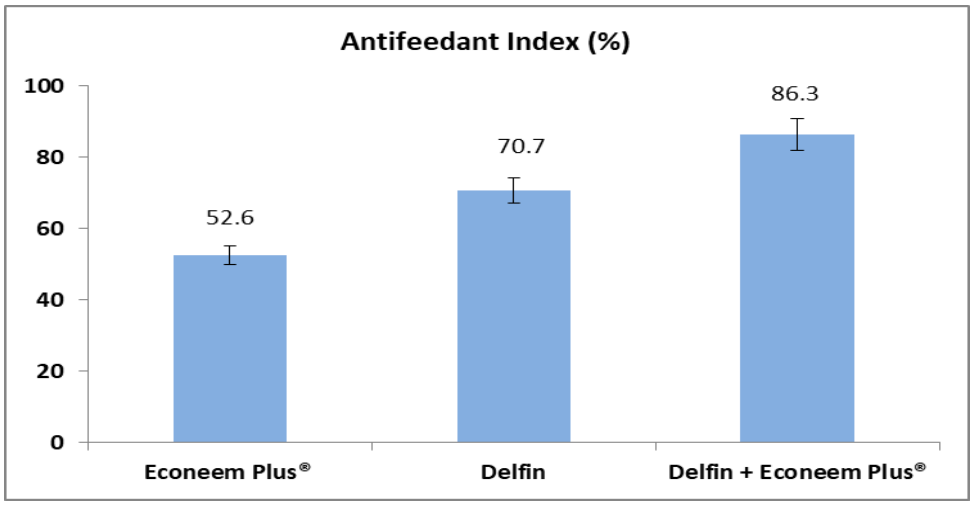
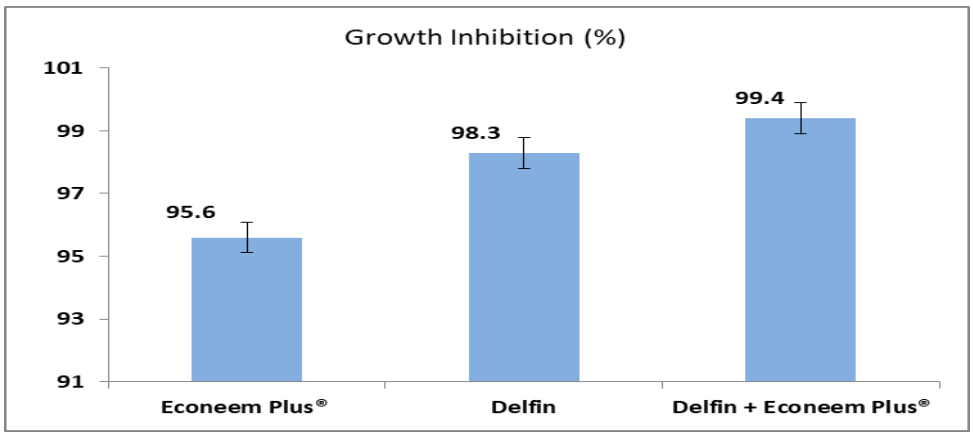


Fig.3 Growth inhibition (%)



Antifeedant Index was recorded highest in the treatment with Delfin + Econeem Plus (86.3%), followed by Delfin (70.7%) and Econeem Plus (52.6%) (Table 2, Fig. 2).

Growth inhibition results at 7 days after treatment also indicated superior effect of the treatment with Delfin+Econeem Plus® (99.4%), when compared to Delfin 98.3% followed by Econeem Plus 95.6% over to control (Table 3, Fig. 3).

The results indicates that organic insecticide Econeem Plus® goes well when combined with Delfin resulting high mortality and antifeedant activity in *Spodoptera litura* larvae

In conclusion, the result of this bio-efficacy study indicate that combination of Delfin and Econeem Plus® is highly effective for inhibiting feeding activity of *Spodoptera litura* larvae and thereby inducing larval mortality. The next best treatment was Delfin alone, which was closely followed by Econeem plus® for management of *Spodoptera litura.*

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