Ecofriendly management of tomato fruit borer, *Helicoverpa armigera* (Hubner)

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ABSTRACT

Studies on the efficacy of different sequential application of microbials *viz.*, nucleopolyhedrovirus of *Helicoverpa armigera* (Hübner) (*Ha*NPV @ 1.5×10^{12} OB/ha), *Bacillus thuringiensis* var. *kurstaki* Berliner (Delfin® 25 WG @1 kg/ha), spinosad 45 SC (@ 75 g a.i./ha) and neem (neemazol 1.2 EC @ 1000ml/ha) against *H. armigera* in comparison with sequential application of synthetic insecticides and untreated control on tomato F_1 hybrid Ruchi. Results of the field experiments showed that different sequential application of microbials and neemazol were equally effective as that of sequential application of synthetic chemical insecticides *viz.*, endosulfan 35 EC (@ 350 g a.i./ha), quinolphos 25 EC (@ 250 g a.i./ha) and indoxacarb 14.5 SC (@ 75 g a.i./ha) in reducing *H. armigera* larval population and fruit damage. Relatively higher number of predatory mirids (*Macrolophus* spp.) and spiders (*Argiope* spp and *Thomisus* spp.) were recorded in microbials and neem applied plots compared to the chemical insecticides treated plot. Thus the microbials and neem could be the best alternatives for the sustainable management of *H. armigera* on tomato with less impact on the naturally occurring predatory arthropods.

Keywords: microbials, spinosad, azadirachtin, indoxacarb, *Helicoverpa armigera*

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is one of the important and remunerative vegetable crops grown around the world for fresh market and processing. The production and productivity of the crop is greatly hampered by the fruit borer, *Helicoverpa armigera* (Hübner) which causes damage to the developing fruits and results in yield loss ranging from 20 to 60 percent (Tewari and Krishnamoorthy, 1984; Lal and Lal, 1996). The indiscriminate use of synthetic chemical pesticides to control this pest resulted in development of resistance (Armes *et al.*, 1992, 1994) and harmful pesticide residues in fruits. The presence of residues of DDT, HCH, endosulfan, malathion and primisphos-methyl in market samples of tomato has been reported (Dikshit *et al.*, 1992; Chalal *et al.*, 1997). Microbials and neem formulations have been reported to reduce the *H. armigera* population and fruit damage in tomato (Praveen, 2000 and Thilagam, 2003). Hence, attempts were made to evaluate the efficacy of different sequential application of nucleopolyhedrovirus of *H. armigera* (*Ha*NPV), *Bacillus thuringiensis* var. *kurstaki* Berliner (*Btk*), neemazol and spinosad as the alternatives to the synthetic chemical pesticides for the sustainable management of *H. armigera* on tomato.

MATERIALS AND METHODS

Two field experiments were conducted during January - April 2005 (season-I) and June - September 2005 (season-II) in farmer's holdings in Alandurai, Coimbatore district to evaluate the efficacy of different sequential application of *Ha*NPV, *Btk*, spinosad and neem in comparison with chemical insecticides for the sustainable management of *H. armigera* on tomato F_1 hybrid Ruchi. The experiments were conducted in a randomized block design with four replications in plot size of 6x5m. The treatments evaluated are as follows: $\mathbf{T_1}$ (HaNPV@1.5×10^{12} OB ha^{-1}-*Btk*@1 kg ha^{-1}-Azadirachtin 1.2 EC@1000 ml ha^{-1}), $\mathbf{T_2}$ (HaNPV@1.5×10^{12} OB ha^{-1}-*Btk*@1 kg ha^{-1}-Spinosad@75g a.i. ha^{-1}), $\mathbf{T_3}$ (*Btk*@1 kg ha^{-1}-HaNPV@1.5×10^{12} OB ha^{-1}-Azadirachtin 1.2 EC@1000 ml ha^{-1}), $\mathbf{T_4}$ (*Btk*@1 kg ha^{-1}-HaNPV@1.5×10^{12} OB ha^{-1}-Spinosad@75g a.i. ha^{-1}), $\mathbf{T_5}$ (neemazol 1.2 EC@1000 ml ha^{-1}-*Btk*@1 kg ha^{-1}- neemazol 1.2 EC@1000 ml ha^{-1}), $\mathbf{T_6}$ **(**neemazol 1.2 EC@1000 ml ha^{-1}-*Btk*@1 kg ha^{-1}-Spinosad@75g a.i. ha^{-1}), $\mathbf{T_7}$-Endosulfan 35 EC@ 350 g a.i.ha^{-1}-Quinalphos 25 EC@ 250 g a.i.ha^{-1}-Indoxacarb @ 75 g a.i.ha^{-1} and $\mathbf{T_8}$ **(**Untreated check).

First spray was given as soon as the incidence of *H. armigera* was noticed and the subsequent sprays were given when the pest crossed the economic threshold. Totally three sprays were given with knapsack hydraulic sprayer at 500 l/ha of spray fluid in each spray. Both *Ha*NPV and *Btk* were applied using Tween 80 (0.01 per cent) as an adjuvant. Observations on the number of larvae (seven days after each spray), fruit damage, predatory

Table 1. Effect of different practices on tomato fruit borer, *H.armigera* during session I

Treatments	Number of larvae/10 plants				Fruit damage (%)	Yield (t ha^{-1})
	Precount	I Spray	II Spray	III Spray		
T_1	10.25	1.00(1.18)^a	0.25(0.84)^a	0.50(0.93)^a	8.98^c	43.65^c
T_2	10.50	0.75(1.06)^a	0.25(0.84)^a	0.00(0.71)^a	4.87^b	47.28^{ab}
T_3	10.25	0.25(0.84)^a	0.50(0.93)^a	0.50(0.97)^a	7.15^c	45.48^{bc}
T_4	10.50	0.25(0.84)^a	0.50(0.93)^a	0.00(0.71)^a	4.68^b	47.66^{ab}
T_5	10.50	0.50(0.93)^a	0.25(0.84)^a	0.50(0.93)^a	8.48^c	45.03^{bc}
T_6	11.25	0.50(0.93)^a	0.25(0.84)^a	0.00(0.71)^a	4.71^b	47.56^{ab}
T_7	10.75	0.75(1.10)^a	0.50(0.93)^a	0.00(0.71)^a	2.42^a	49.81^a
T_8	10.75	6.00(2.55)^b	6.50(2.64)^b	6.75(2.69)^b	31.17^d	36.29^d

T_1 - HaNPV - *Btk* – neemazol, T_2 - HaNPV - *Btk* – Spinosad, T_3 - *Btk* - HaNPV – Azadirachtin, T_4 - *Btk* - HaNPV – Spinosad, T_5 - Azadirachtin - *Btk* - Azadirachtin, T_6 - Azadirachtin - *Btk* – Spinosad, T_7 - Endosulfan - Quinalphos – Indoxacarb, T_8 - Untreated check; Values in parentheses are $\sqrt{x+0.5}$ transformed values; In a column, means followed by a common letter(s) are not significantly different by DMRT (P=0.05)

mirids and spiders were recorded after each spray in ten randomly selected plants from each plot. At each picking, the yield of fruits was recorded from each plot and per ha yield was worked out. The statistical analysis of data obtained from the experiments was carried out in IRRISTAT 3.01 and the means were separated by Duncan's Multiple Range Test (DMRT).

RESULTS

H. armigera Larval population

Pretreatment observations showed that the number of larvae ranged from 10.25 to 12.25 per ten plants. The seventh day counts after each spray revealed that the sequential application of *Ha*NPV, *Btk*, neemazol and spinosad were equally as effective as sequential application of synthetic chemical insecticides in reducing the larval population of *H. armigera*. Larval counts showed that, all the treatments were significantly ($p < 0.05$) superior to untreated check in both seasons (Table 1 and 2).

Fruit damage and Yield

All the ecofriendly management strategies were effective in reducing the fruit damage caused by *H. armigera*. However, variation was observed in different sequential applications of *Ha*NPV, *Btk,* neemazol and spinosad. Among the treatments sequential application of

Table 2. Effect of different practices on tomato fruit borer, *H. armigera* during season II

Treatments	Number of larvae/10 plants				Fruit damage (%)	Yield (t ha^{-1})
	Precount	I Spray	II Spray	III Spray		
T_1	10.50	1.25(1.31)^b	0.00(0.71)^a	0.75(1.06)^a	9.49^c	43.90^c
T_2	10.75	1.00(1.18)^b	0.25(0.84)^a	0.00(0.71)^a	5.54^b	47.41^{ab}
T_3	12.00	0.00(0.71)^a	0.75(1.06)^a	0.50(0.93)^a	8.81^c	45.48^{bc}
T_4	12.25	0.00(0.71)^a	0.50(0.93)^a	0.25(0.84)^a	5.32^b	47.22^{ab}
T_5	10.75	0.50(0.93)^{ab}	0.00(0.71)^a	1.00(1.14)^a	9.14^c	44.81^{bc}
T_6	10.50	0.75(1.06)^{ab}	0.25(0.84)^a	0.00(0.71)^a	5.24^b	47.24^{ab}
T_7	10.50	0.50(0.97)^{ab}	0.00(0.71)^a	0.00(0.71)^a	3.14^a	49.77^a
T_8	10.75	6.25(2.60)^c	6.25(2.60)^b	6.75(2.69)^b	32.45^d	35.61^d

T1 - HaNPV - *Btk* – neemazol, T2 - HaNPV - *Btk* – Spinosad, T3 - *Btk* - HaNPV – Azadirachtin, T4 - *Btk* - HaNPV – Spinosad, T5 - Azadirachtin - *Btk* - Azadirachtin, T6 - Azadirachtin - *Btk* – Spinosad, T7 - Endosulfan - Quinalphos – Indoxacarb, T8 - Untreated check;Values in parentheses are transformed values; In a column, means followed by a common letter(s) are not significantly different by DMRT (P=0.05)

Table 3. Effect of sustainable management practices on predatory mirid population (No. /10 plants)

Treat-ments	Mean number of predatory mirids							
	Season I				Season II			
	Precount	I Spray	II Spray	III Spray	Precount	I Spray	II Spray	III Spray
T_1	14.25(3.84)[a]	15.75(4.03)[a]	17.00(4.18)[a]	12.50(3.60)[c]	14.50(3.87)[a]	16.50 (4.12)[a]	16.75 (4.15)[b]	12.75(3.64)[cd]
T_2	14.50(3.87)[a]	16.25(4.09)[a]	17.00(4.18)[a]	15.75(4.03)[b]	14.50(3.87)[a]	16.50 (4.12)[a]	17.25(4.21)[ab]	14.75(3.90)[bc]
T_3	14.25(3.84)[a]	16.25(4.09)[a]	17.00(4.18)[a]	12.25(3.57)[c]	15.00 (3.94)[a]	16.50(4.12)[a]	17.50 (4.24)[ab]	12.00(3.53)[d]
T_4	14.75(3.90)[a]	16.00(4.06)[a]	17.50(4.24)[a]	15.50(4.00)[b]	14.50 (3.87)[a]	16.75 (4.15)[a]	17.75(4.27)[ab]	15.25(3.97)[ab]
T_5	14.50(3.87)[a]	10.25(3.27)[b]	12.50(3.60)[b]	12.25(3.57)[c]	14.75 (3.90)[a]	10.25(3.28)[b]	11.75 (3.50)[c]	12.50(3.60)[d]
T_6	14.00(3.80)[a]	9.50 (3.16)[b]	12.25(3.57)[b]	15.00(3.94)[b]	14.50 (3.87)[a]	9.50(3.16)[b]	11.50 (3.46)[c]	14.75(3.90)[b]
T_7	14.25(3.84)[a]	2.75 (1.79)[c]	0.75(1.06)[c]	0.50(0.97)[d]	14.50 (3.87)[a]	3.50(2.00)[c]	1.25(1.27)[d]	0.50(0.97)[e]
T_8	14.75(3.90)[a]	16.75(4.15)[a]	19.25(4.44)[a]	18.75(4.39)[a]	15.25(3.97)[a]	15.75(4.03)[a]	19.25(4.44)[a]	17.00(4.18)[a]

Values in parentheses are transformed values; In a column, means followed by a common letter(s) are not significantly different by DMRT (P = 0.05)

endosulfan-quinalphos-indoxacarb recorded lowest fruit damage and in the ecofriendly management strategies fruit damage ranged from 4.68 to 9.49 per cent in both seasons. All the treatments recorded significantly increased fruit yield over the untreated check. However, the highest fruit yield was recorded in endosulfan-quinalphos-indoxacarb treated plots, which was on par with azadirachtin-*Btk*-spinosad, *Ha*NPV-*Btk*-spinosad, *Btk*-*Ha*NPV-spinosad treated plots.

Mirids and spiders populations

Predatory mirids, *Macrolophus* spp. and spiders, *Argiope* spp. and *Thomisus* spp. were recorded in tomato ecosystem during the study period. Highest number of predatory mirids and spiders was recorded in untreated check plots but comparable with those in *Ha*NPV, *Btk*, azadirachtin and spinosad treated plots, whereas endosulfan-quinalphos-indoxacarb treated plots had the lowest population which was significantly different from the untreated check (Table 3 and 4).

DISCUSSION

The results of the field experiments have shown that different sequential application of *Ha*NPV, *Btk*, azadirachtin and spinosad can provide control of *H. armigera* larval population which is comparable with endosulfan-quinalphos-indoxacarb application. However, significant differences between ecofriendly management strategies and synthetic chemical insecticides were observed with respect to fruit damage and yield (Table 1 and 2). The reason for the superiority of chemical insecticides in reducing larval population and fruit damage compared to different sequential application of *Ha*NPV, *Btk*, azadirachtin and spinosad is probably due to their quicker action against target pest. The variation in fruit damage and yield in different sequential application of *Ha*NPV, *Btk*, azadirachtin and spinosad, might be due to the slow rate of kill in *Ha*NPV and azadirachtin. The efficacy of *Ha*NPV, *Btk* and azadirachtin in the control of *H. armigera* on tomato has been reported earlier (Praveen, 2000). In the present study, different sequential application of *Ha*NPV, *Btk*, azadirachtin and spinosad and endosulfan-quinalphos-indoxacarb were effective in reducing the larval population and fruit damage and increased the fruit yield. These results are in conformity with the findings of Thilagam (2003), in the control of *H. armigera* on tomato.

The number of predatory mirids and spiders was the highest in untreated control plots but comparable with those in *Ha*NPV, *Btk*, azadirachtin and spinosad treated plots whereas endosulfan-quinalphos-indoxacarb treated plot recorded the lowest population (Tables 3 and 4). Toxicity of endosulfan, quinalphos and indoxacarb to predatory mirids and spiders (Singh, 1995; Thilagam, 2007) has been reported. Hence, the reduction in the population of predatory arthropods in synthetic chemical treatments was only due to their toxic effects on predators. Though endosulfan-quinalphos-indoxacarb treatment recorded the lowest fruit damage and highest fruit yield during both seasons, this should be over weighed against the context of deleterious effects of synthetic chemical insecticides

Table 4. Effect of sustainable management practices on spiders population (No. /10 plants)

Treat-ments	Mean number of spiders							
	Season I				Season II			
	Precount	I Spray	II Spray	III Spray	Precount	I Spray	II Spray	III Spray
T_1	0.75(1.06)[a]	0.75(1.06)[a]	0.75(1.06)[a]	1.25(1.27)[a]	1.25(1.27)[a]	0.75(1.06)[a]	1.00(1.18)[a]	1.25(1.27)[a]
T_2	0.75(1.06)[a]	0.75(1.06)[a]	0.75(1.06)[a]	0.75(1.06)[a]	1.25(1.27)[a]	0.75(1.06)[a]	1.25(1.27)[a]	0.75(1.06)[a]
T_3	1.00(1.14)[a]	1.00(1.14)[a]	1.00(1.14)[a]	1.00(1.14)[a]	1.25(1.27)[a]	1.00(1.14)[a]	1.25(1.27)a	1.00(1.14)[a]
T_4	0.75(1.06)[a]	0.75 (1.06)[a]	0.75(1.06)[a]	0.75(1.06)[a]	1.25(1.27)[a]	0.75(1.06)[a]	1.00(1.18)[a]	0.75(1.06)[a]
T_5	0.50(0.93)[a]	0.50(0.93)[a]	0.75(1.06)[a]	1.00(1.14)[a]	0.75(1.06)[a]	0.50(0.93)[a]	1.00(1.14)[a]	1.00(1.14)[a]
T_6	0.50(0.97)[a]	0.50(0.97)[a]	0.75(1.06)[a]	0.75(1.06)[a]	1.25(1.26)[a]	0.50(0.97)[a]	1.00(1.18)[a]	0.75(1.06)[a]
T_7	0.75(1.06)[a]	0.00(0.71)[b]	0.00(0.71)[b]	0.25(0.84)[b]	1.00(1.18)[a]	0.00(0.71)[b]	0.00(0.71)[b]	0.25(0.84)[b]
T_8	0.75(1.06)[a]	0.75(1.06)[a]	1.25(1.27)[a]	1.50(1.40)[a]	1.50(1.40)[a]	1.50(1.40)[a]	2.00(1.56)[a]	2.00(1.58)[a]

Values in parentheses are transformed values ; In a column, means followed by a common letter(s) are not significantly different by DMRT (P=0.05)

on the population of naturally occurring arthropods and proper decision should be taken with regard to the choice of treatment for the sustainable management.

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