Management of *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) using its nucleopolyhedrovirus (HearNPV) formulations applied by different methods on tomato

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**ABSTRACT:** Efficacy of some adjuvants against *Helicoverpa armigera* on tomato when applied with NPV formulations and sprayed by two different equipments (controlled droplet applicator and backpack hydraulic sprayer) was evaluated. Results showed that *H. armigera* populations could be effectively controlled by the virus on tomato. The data on larval population, fruit damage, and yield indicated that adjuvants could enhance significantly the efficacy of the virus preparations and there was no significant difference between application methods.

**KEY WORDS:** Adjuvants, field efficacy, *Helicoverpa armigera*, nucleopolyhedrovirus, sprayer, tomato.

**INTRODUCTION**

*Helicoverpa armigera* is one of the important polyphagous pests affecting a number of crops including tomato. With increasing problems due to insecticide resistance in *H. armigera*, microbial insecticides based on nucleopolyhedrovirus (HearNPV) play an important role in the successful management of this pest. As with many microbial insecticides, HearNPV is also susceptible to inactivation by various environmental factors like UV spectrum of solar radiation, leaf pH, etc. The efficiency of HearNPV has been amply demonstrated on various crops such as tomato (Narayanan and Gopalakrishnan, 1990), field bean or *Lablab* bean (Muthuswami et al., 1994), pigeonpea (Muthiah and Rabindra, 1991), chickpea (Rabindra et al., 1994), sunflower (Rabindra et al., 1985), cotton (Rabindra and Jayaraj, 1995) and groundnut (Dhandapani et al., 1993). In addition to the above it is also important to find out a suitable cost effective method of application. The purpose of this study was to evaluate the efficacy of some of the adjuvants against *H. armigera* on tomato when applied with NPV formulations. The investigation was also extended to evaluate the efficacy of ULV as well as high volume applications of the HearNPV formulation.

**MATERIALS AND METHODS**

The talc-based wettable powder formulation of nuclear polyhedrosis virus of *H. armigera* was prepared in the laboratory following the method of Rabindra et al. (1988). The efficacy of the formulated HearNPV as well as its unformulated suspension applied by two different spray equipment, viz., controlled droplet applicator (CDA) and backpack hydraulic sprayer, was tested in a farmer’s field (All-round) in Rajankunte during June-September 2006.

The experiment was laid out in a factorial randomized block design with three replications. The plot size was 8 × 5m and a gangway of one meter was allowed all around. Spacing of the tomato plants was 50cm x 1m. Recommended agronomic practices were followed during the crop growth. Three rounds of spraying were given at 10 days interval during the evening hours, commencing the first at 45 days after sowing when the plants were at flowering stage and the incidence of early instars larvae of the pest was seen. The treatments evaluated in these experiments were as follows:

i) Wettable powder @ $1.5 \times 10^{12}$ polyhedral occlusion bodies (OB) ha$^{-1}$ + Adjuvants (molasses 625g, Tinopal 25g, and lampblack 12.5g) + 0.01 per cent of Triton X-100

ii) Wettable powder @ $1.5 \times 10^{12}$ OB ha$^{-1}$ + 0.01 per cent of Triton X-100

iii) Water suspension of virus @ $1.5 \times 10^{12}$ OB ha$^{-1}$ + Adjuvants (molasses 625g, Tinopal 25g, and lampblack 12.5g) + 0.01 per cent of Triton X-100

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iv) Water suspension of virus @ $1.5 \times 10^{12}$ OB ha$^{-1} + 0.01$ per cent of Triton X-100®  

v) Water suspension of the commercial HearNPV @ $1.5 \times 10^{12}$ OB ha$^{-1}$ + Adjuvants (crude sugar 625g, and Robin blue 12.5ml) + 0.01 per cent of Triton X-100®  

vi) Monocrotophos (450g. a. i. ha$^{-1}$)  

vii) Untreated control

The main treatments were applied with i) controlled droplet applicator (CDA) with a spray fluid of volume 12.5 l ha$^{-1}$, and ii) backpack hydraulic sprayer with 500 l ha$^{-1}$.

**Observations**

**Pre-treatment**

Observations were taken before each spray on the number of larvae and per cent incidence of damaged fruits in each plot from 10 randomly selected plants.

**Post-treatment**

Observations were taken at 5, 7, and 10 days after each application on the number of larvae per 10 randomly selected plants per plot, number of fruits (bored and not bored) per 10 randomly selected plants and per cent incidence of damaged fruits from each plot. Yield at harvest (kg) from 10 randomly selected plants in each plot (undamaged fruits were considered) was recorded and then yield / ha was computed.

**RESULTS AND DISCUSSION**

**Larval population**

Pre-treatment counts on larval population before application of the treatments showed that there were 16-20 larvae per 10 plants. In all treated plots, the effects of the treatments were observed five days after the first application, and number of larvae were significantly less compared to untreated control (Table 1). Virus applied with the adjuvant mix gave better control than virus treatments indicated a progressive increase, but was always significantly lower than in control. In almost all the observations, the virus was found to be as effective as monocrotophos. The laboratory formulation was as effective as the commercial formulation (Table 1). After the second and third (Table 1 and 2) rounds of applications better results were obtained in the sense that the effect of treatments persisted beyond five days and even on the 10th day, very good control of larval population was seen in the different treatments. Larval population after second round of spraying was significantly less in NPV adjuvant mix compared with that of virus alone. Comparison of data after third round of spraying also showed that there were no perceptible differences in the efficacies of the different treatments.

**Fruit damage**

The post-treatment observations on 5, 7, and 10 days after the first round of spray indicated that all the virus treatments with or without adjuvants were equally effective in reducing the damage to the fruits (Table 3). Data recorded after the second and third sprays, however, showed that the wettable powder formulation was as effective as the unformulated fresh virus only when applied along with the adjuvant mix.

Results of these experiments showed that all the virus treatments effectively controlled the fruit damage when applied either by the CDA or backpack hydraulic sprayer but addition of adjuvants significantly enhanced the efficacy of the treatments (Table 3).

**Yield**

All the virus treatments enhanced the yield of fruits significantly. Addition of adjuvants to the virus, however, gave better yields and cost of benefits comparable to that of the chemical insecticide (Table 3). Comparison of the efficacy of the virus + adjuvants applied by the two spray equipments showed no significant differences between the two equipments in terms of larval population, fruit damage as well as fruit yield (Table 4).

Results of the field experiment conducted to evaluate the efficacy of HearNPV formulations either alone or in combination with adjuvants applied by two different sprayers showed that *H. armigera* populations could be effectively controlled on tomato by NPV. The data on larval population, fruit damage, and yield indicated that adjuvants could enhance significantly the efficacy of the virus preparations. After the third spray, the virus was on par with monocrotophos (Tables 1-3). Molasses can provide the triple function of phagostimulance, evaporation retardation and UV-protection and thereby improve the performance of the virus. Both Tinopal, an optical brightener, and lampblack act as UV-protectants. These components used in the formulation can be useful in getting better results with microbial pesticides.

Application of three to five rounds of HearNPV @ 250LE ha$^{-1}$ ($1.5 \times 10^{12}$ OB ha$^{-1}$) along with adjuvants during the evening hours at weekly intervals right from the flower initiation had resulted in significant reduction in the fruit borer damage (Mohan *et al.* 1996; Sivaprakasam, 1998; Gopalkrishnan and Asokan, 1998). These findings reinforce the present study.

Even though yield of fruits at harvest was high when backpack hydraulic sprayer was used, there were no significant differences between the two equipments (Table 4). Hence, HearNPV can be applied by any of these sprayers for the control of *H. armigera* on tomato. However, the
Table 1. Field efficacy of HearNPV against larval population of *H. armigera* on tomato using controlled droplet application

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Number of larvae per 10 plants after</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First spray</td>
<td>Pretreatment count</td>
<td>5DAT*</td>
<td>7DAT</td>
<td>10DAT</td>
<td>Pretreatment count</td>
<td>5DAT</td>
<td>7DAT</td>
</tr>
<tr>
<td>NPV Wettable Powder formulation + adjuvant</td>
<td>18.0</td>
<td>4.3^b</td>
<td>7.0^b</td>
<td>8.3^b</td>
<td>9.0^a</td>
<td>2.7^a</td>
<td>2.3a</td>
<td>3.0^a</td>
</tr>
<tr>
<td>NPV Wettable Powder formulation</td>
<td>16.7</td>
<td>8.3^b</td>
<td>9.7^bc</td>
<td>10.0^b</td>
<td>10.3^b</td>
<td>6.0^b</td>
<td>6.7^b</td>
<td>6.7^b</td>
</tr>
<tr>
<td>NPV unformulated + adjuvant</td>
<td>17.7</td>
<td>4.7^abc</td>
<td>7.3^b</td>
<td>8.3^b</td>
<td>10.3^b</td>
<td>3.3^a</td>
<td>3.0^a</td>
<td>2.7^a</td>
</tr>
<tr>
<td>NPV unformulated</td>
<td>20.3</td>
<td>8.7^c</td>
<td>10.3^b</td>
<td>10.7^b</td>
<td>11.7^b</td>
<td>6.7^b</td>
<td>7.0^b</td>
<td>7.0^b</td>
</tr>
<tr>
<td>Commercial unformulated NPV + adjuvant</td>
<td>18.7</td>
<td>4.3^b</td>
<td>7.7^b</td>
<td>8.7^b</td>
<td>8.0^a</td>
<td>3.3^a</td>
<td>2.7^a</td>
<td>2.7^a</td>
</tr>
<tr>
<td>Monocrotophos (450 g.a.i. ha⁻¹)</td>
<td>21.3</td>
<td>3.7^a</td>
<td>3.3^a</td>
<td>4.3^a</td>
<td>6.0^a</td>
<td>2.3^a</td>
<td>2.0^a</td>
<td>2.0^a</td>
</tr>
<tr>
<td>Untreated control</td>
<td>19.3</td>
<td>15.3^d</td>
<td>14.7^c</td>
<td>15.3^c</td>
<td>16.7^c</td>
<td>16.0^c</td>
<td>13.3^c</td>
<td>13.0^c</td>
</tr>
</tbody>
</table>

In a column means followed by similar letters are not significantly different by DMRT (P = 0.05); DAT = Days after treatment
Table 2. Field efficacy of HearNPV against larval population of *H. armigera* on tomato using backpack hydraulic sprayer

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Number of larvae per 10 plants after</th>
<th>First spray</th>
<th>Second spray</th>
<th>Third spray</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pretreatment count</td>
<td>5DAT</td>
<td>7DAT</td>
<td>10DAT</td>
</tr>
<tr>
<td>Pretreatment count</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NPV Wettable Powder formulation + adjuvant</td>
<td>19.7</td>
<td>4.7b</td>
<td>5.3b</td>
<td>7.0b</td>
</tr>
<tr>
<td>NPV Wettable Powder formulation</td>
<td>17.3</td>
<td>7.3b</td>
<td>7.0b</td>
<td>8.7b</td>
</tr>
<tr>
<td>NPV unformulated + adjuvant</td>
<td>16.7</td>
<td>5.0b</td>
<td>5.7b</td>
<td>7.3b</td>
</tr>
<tr>
<td>NPV unformulated</td>
<td>18.7</td>
<td>7.3b</td>
<td>6.7b</td>
<td>9.3b</td>
</tr>
<tr>
<td>Commercial unformulated NPV + adjuvant</td>
<td>19.0</td>
<td>5.7b</td>
<td>6.0b</td>
<td>7.7b</td>
</tr>
<tr>
<td>Monocrotophos (450g.a.i. ha⁻¹)</td>
<td>16.3</td>
<td>3.0a</td>
<td>3.7a</td>
<td>5.0a</td>
</tr>
<tr>
<td>Untreated control</td>
<td>20.7</td>
<td>14.7c</td>
<td>14.0c</td>
<td>12.7c</td>
</tr>
</tbody>
</table>

In a column means followed by similar letters are not significantly different by DMRT (P = 0.05)
controlled droplet applicator could be recommended as its working spray volume (12.5 L ha$^{-1}$) is lower than that of backpack hydraulic sprayer (500L ha$^{-1}$). Results of the present study on spray equipment are in agreement with previous findings of Stacey et al. (1980) who evaluated some selected methods of application of NPV against Helicoverpa on cotton and found no difference in efficacy when the virus was applied by either a mist blower or hydraulic equipment for the control of the pest. Also, Rabindra and Jayaraj (1988, 1995) found no significant differences in the efficacy of three types of sprayers, viz., controlled droplet applicator (CDA), backpack hydraulic sprayer and mist blower, against H. armigera on cotton. These results indicate that farmers can use any one of the sprayers depending upon the situations. In areas of water scarcity, the CDA can be used. The motorized mist blower can cover larger areas in a day when compared to the backpack sprayer.

**REFERENCES**


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