J. Biol. Control, 23(2):145-149, 2009

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

A. MEHRVAR[1], R. J. RABINDRA[2], K. VEENAKUMARI[2] and G. B. NARABENCHI[3]

[1]Department of Plant Protection, Faculty of Agriculture, University of Maragheh, Maragheh, Iran.
[2]Project Directorate of Biological Control (ICAR), Post Bag No. 2491, H. A. Farm Post, Bellary Road, Hebbal, Bangalore 560024, Karnataka, India.
[3]Biocontrol Research Laboratories, Pest Control (India) Pvt. Ltd., Bangalore 560064, Karnataka, India.
E-mail: alimehrvar@yahoo.co.uk

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

[2]Corresponding Address: Project Directorate of Biological Control, Post Bag No. 2491, H. A. Farm Post, Bellary Road, Hebbal, Bangalore 560024, Karnataka, India.

iv) Water suspension of virus @ 1.5 × 10^{12} OB ha^{-1} + 0.01 per cent of Triton X-100®
v) Water suspension of the commercial HearNPV @ 1.5 × 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 25 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 10^{th} 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 × 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; Gopalakrishnan 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

Treatments	Number of larvae per 10 plants after											
	First spray				Second spray				Third spray			
	Pretreatment count	5DAT*	7DAT	10DAT	Pretreatment count	5DAT	7DAT	10DAT	Pretreatment count	5DAT	7DAT	10DAT
NPV Wettable Powder formulation + adjuvant	18.0	4.3^{ab}	7.0^{ab}	8.3^{b}	9.0^{a}	2.7^{a}	2.3a	3.0^{a}	3.7^{a}	0.7^{a}	1.0^{a}	0.7^{a}
NPV Wettable Powder formulation	16.7	8.3^{bc}	9.7^{bc}	10.0^{b}	10.3^{b}	6.0^{b}	6.7^{b}	6.7^{b}	6.7^{b}	3.3^{b}	1.3^{a}	1.7^{a}
NPV unformulated + adjuvant	17.7	4.7^{abc}	7.3^{ab}	8.3^{b}	10.3^{b}	3.3^{a}	3.0^{a}	2.7^{a}	3.3^{a}	1.0^{a}	1.0^{a}	0.7^{a}
NPV unformulated	20.3	8.7^{c}	10.3^{bc}	10.7^{b}	11.7^{b}	6.7^{b}	7.0^{b}	7.0^{b}	7.3^{b}	3.7^{b}	1.7a	1.3^{a}
Commercial unformulated NPV + adjuvant	18.7	4.3^{ab}	7.7^{ab}	8.7^{b}	8.0^{a}	3.3^{a}	2.7^{a}	2.7^{a}	3.7^{a}	1.3^{a}	1.3^{a}	0.7^{a}
Monocrotophos (450 g.a.i. ha^{-1})	21.3	3.7^{a}	3.3^{a}	4.3^{a}	6.0^{a}	2.3^{a}	2.0^{a}	2.0^{a}	2.7^{a}	0.3a	0.7^{a}	0.7^{a}
Untreated control	19.3	15.3^{d}	14.7^{c}	15.3^{c}	16.7^{c}	16.0^{c}	13.3^{c}	13.0^{c}	10.7^{c}	10.7$_{c}$	12.3$_{b}$	11.3^{b}

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

Treatments	Number of larvae per 10 plants after											
	First spray				Second spray				Third spray			
	Pretreatment count	5DAT	7DAT	10DAT	Pretreatment count	5DAT	7DAT	10DAT	Pretreatment count	5DAT	7DAT	10DAT
NPV Wettable Powder formulation + adjuvant	19.7	4.7^{ab}	5.3^{ab}	7.0^{ab}	8.3^{b}	2.3^{a}	3.0^{a}	2.3^{a}	3.0^{a}	1.0_{a}	0.7^{a}	0.7^{a}
NPV Wettable Powder formulation	17.3	7.3^{b}	7.0^{b}	8.7^{ab}	8.7^{a}	6.3^{b}	5.7^{b}	5.7^{b}	6.3^{b}	3.7^{c}	1.3^{a}	2.0^{a}
NPV unformulated + adjuvant	16.7	5.0^{ab}	5.7^{ab}	7.3^{ab}	8.3^{a}	4.3^{ab}	4.0^{ab}	3.0^{a}	3.3^{a}	1.3^{ab}	0.7^{a}	0.7^{a}
NPV unformulated	18.7	7.3^{b}	6.7^{b}	9.3^{b}	9.7^{b}	7.0^{b}	5.7^{b}	5.3^{b}	5.7^{ab}	3.0^{bc}	1.7^{a}	1.7^{a}
Commercial unformulated NPV + adjuvant	19.0	5.7^{ab}	6.0^{b}	7.7^{ab}	10.0^{b}	4.7^{ab}	3.7^{a}	2.7^{a}	3.3^{a}	1.3^{ab}	1.0^{a}	1.0^{a}
Monocrotophos (450g.a.i. ha^{-1})	16.3	3.0^{a}	3.7^{a}	5.0^{a}	6.7^{a}	2.0^{a}	2.7^{a}	2.3^{a}	3.0^{a}	0.3^{a}	0.3^{a}	0.7^{a}
Untreated control	20.7	14.7^{c}	14.0^{c}	12.7^{c}	14.3^{c}	14.2^{c}	12.4^{c}	12.4^{c}	11.0^{c}	9.7^{d}	10.3^{b}	10.3^{b}

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

Dhandapani, N., Sundara Babu, P.C., Jayaraj, S. and Rabindra, R.J. 1993. Field efficacy of nuclear polyhedrosis virus against *Heliothis armigera* (Hbn.) and *Spodoptera litura* (Fb.) on different host crops. *Tropical Agriculture (Trinidad)*, **70**: 320-324.

Gopalakrishnan, C. and Asokan, R. 1998. On-farm trials of *Ha*NPV against *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) in tomato, pp. 215-217. In: *Advances in IPM for horticultural ecosystems*, In: Proceedings of National Symposium on Pest Management Horticultural Crops, Indian Institute of Horticultural Research, Bangalore, India.

Mohan, K.S., Asokan, R. and Gopalakrishnan, C. 1996. Isolation and field application of a nuclear polyhedrosis virus for the control of the fruit borer, *Helicoverpa armigera* (Hübner) on tomato. *Pest Management in Horticultural Ecosystems*, **2**: 1-8.

Muthiah, C. and Rabindra, R.J. 1991. Control of gram pod borer (*Heliothis armigera*) on pigeonpea (*Cajanus cajan*) with controlled droplet application of nuclear polyhedrosis virus and effect of oral feeding of virus on mulberry silkworm (*Bombyx mori*). *Indian Journal of Agricultural Sciences*, **61**: 449-452.

Muthuswami, M., Rabindra, R.J. and Jayaraj, S. 1994. Evaluation of certain adjuvants as phagostimulants and UV protectants of nuclear polyhedrosis virus of *Helicoverpa armigera* (Hbn.). *Journal of Biological Control*, **8**: 27-33.

Narayanan, K. and Gopalkrishnan, C. 1990. Integrated control of *Heliothis armigera* (Hübner) with their pathogens and pesticides in certain Horticultural crops, pp 165-176. In: Jayaraj, S., Uthamasamy, S. and Gopalan, M. (Eds.). *Heliothis* management, Proceedings of National Workshop, Tamil Nadu Agricultural University, Coimbatore. India.

Rabindra, R. J. and Jayaraj, S. 1988. Efficacy of nuclear polyhedrosis virus with adjuvants as high volume and ultra low volume applications against *Heliothis armigera* (Hbn.) on chickpea. *Tropical Pest Management*, **34**: 441-444.

Rabindra, R. J. and Jayaraj, S. 1995. Management of *Helicoverpa armigera* with nuclear polyhedrosis virus on cotton using different spray equipment and adjuvants. *Journal of Biological Control*, **9**: 34-36.

Rabindra, R. J., Jayaraj, S. and Balasubramanian, M. 1985. Efficacy of nuclear polyhedrosis virus for the control of *Heliothis armigera* (Hübner). *Journal of Entomological Research*, **9**: 246-248.

Rabindra, R. J., Muthaiah, C. and Jayaraj, S. 1988. Laboratory evaluation of a CDA formulation of nuclear polyhedrosis virus against *Heliothis armigera* (Hbn.). *Journal of Entomological Research*, **12**: 166-168.

Rabindra, R. J., Muthuswami, M., Arivudainambi, S., Santharam, G. and Jayaraj, S. 1994. Economic threshold level for *Helicoverpa armigera* on chickpea with reference to the use of nuclear polyhedrosis virus. *Proceeding of IV International Colloquium on Invertebrate Pathology and Microbiological Control,* Montpellier, France.

Sivaprakasam, N. 1998. Control of tomato fruit borer (*Helicoverpa armigera*) by nuclear polyhedrosis virus in comparison with other treatments. *Indian Journal of Agricultural Sciences*, **68**: 801-802.

Stacey, A. L., Luttell, R., Yearian, W. C. and Young, S., 1980. Field evaluation of baculovirus of *Heliothis* on cotton using selected application methods. *Journal of Georgia Entomological Society,* **15**: 365-372.

(Received: 15.03.07; Revised: 13.06.08; Accepted: 12.01.09)