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Control of *Heliothis armigera* (Hbn.) on Chickpea with Controlled Droplet Application of Nuclear Polyhedrosis Virus in Combination with Endosulfan and Boric Acid

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ABSTRACT

Results of a laboratory experiment showed that boric acid 1% or magnesium sulphate at 0.5 and 1.0 % increased the mortality of second instar larvae of *Heliothis armigera* (Hbn.) due to nuclear polyhedrosis virus. In the field experiment with chickpea cv. Shoba, application of NPV @ 250 LE + boric acid 125 g/ha significantly reduced the larval population over application of NPV alone. Addition of endosulfan 175 g a.i./ha to a mixture of NPV 125 LE + boric acid 125 g/ha was significantly more effective than application of NPV + boric acid in controlling *H. armigera* larvae. However, a combination of NPV 250 LE + endosulfan 175 g a.i./ha was the most effective in controlling the pest and increasing the yield.

Key Words : Nuclear polyhedrosis virus, boric acid, MgSo4, ZnSo4, endosulfan, *Heliothis armigera,* control, ULV, chickpea

Successful control of the gram caterpillar *Heliothis armigera* (Hbn.) with controlled droplet application (CDA) of nuclear polyhedrosis virus (NPV) in 20% crude sugar (jaggery) was demonstrated by Rabindra and Jayaraj (1986). Application of NPV with half the recommended dose of endosulfan had also given good control of *H. armigera* on chickpea (Rabindra and Jayaraj, 1988b). Boric acid is known to increase the effectiveness of nuclear polyhedrosis viruses (Yadava, 1971; Shapiro and Bell, 1982; Rao *et al.,* 1987). This paper deals with the results of laboratory and field experiments to evaluate the efficacy of a combination of NPV with certain chemicals like boric acid, MgSo4 and ZnSo4 as well as the field efficacy of ULV application of NPV in combination with boric acid and endosulfan for the control of *H. armigera* on chickpea.

MATERIALS AND METHODS

A laboratory bio-assay was conducted to evaluate the efficacy of boric acid, MgSo4 and ZnSo4 in increasing the efficacy of NPV against *H. armigera* larvae. The nuclear polyhedrosis virus propagated in fourth instar larvae was purified by differential centrifugation and suspended in distilled water. Counts were made with a new improved Neubauer haemocytometer and the strength of polyhedral occlusion bodies (POB) assessed. A virus suspension containing 10^4 POB/ml was prepared in distilled water containing 0.01% Triton X 100 as a surfactant and weighed quantities in each of boric acid, MgSo4 and ZnSo4 added at 1.0, 0.5 and 0.1% concentrations. The efficacy of these treatments was compared with that of NPV applied alone against second instar larvae of *H. armigera* by the leaf - dip method described by Rabindra and Jayaraj (1988a). The treatments were replicated thrice and suitable control was maintained to check for virus infection in the test insect population.

The field experiment was conducted in a randomised block design with three replications and with a plot size of 5 x 4 m using chickpea cv. 'Shoba'. The plots had a gangway of 1.5 m all around. By suitably diluting the stock, virus treatments representing 250 LE (1.5×10^{12} POB) and 125 LE (0.75×10^{12} POB) per ha were prepared. Before application of different treatments (Table 2), the larval population on 10 randomly selected plants in each plot was recorded. All the treatments except NPV without adjuvant and endosulfan were applied in 20% crude sugar. Teepol was added at 0.5% to all the virus treatments. A cloth screen (1.75 m high) held all around the plots prevented the spray drift to adjacent plots. The treatments were applied twice at 20 days interval with a hand-held, battery operated controlled droplet applicator (Heli spray of Thompsons Motronics, Ahmedabad) using a spray fluid of 12.5 litres per ha. Larval counts 5 and 7 days after each treatment and at podding stage, the percentage pod damage were recorded in 10 randomly selected plants leaving the plants in the border. At harvest, yield of grain was recorded.

The data on larval numbers were converted to $\sqrt{X + 0.5}$ and the percentages into angles and after analysis of variance, the means were separated by Duncan's multiple range test.

RESULTS AND DISCUSSION

Results of laboratory test showed that boric acid 1% and MgSo4 at 0.5 and 1.0% could significantly increase the mortality caused by NPV. Boric acid at lower doses and ZnSo4 at all doses were not effective (Table 1).

In the field experiment, the data on larval population recorded on the fifth day of treatment showed that

Table 1. Efficacy of some chemicals in increasing the mortality of second instar larvae of *H. armigera* due to NPV

Treatments*		Mean % Mortality@
Boric acid	1.0%	78.5a
	0.5%	48.5d
	0 1%	51.5cd
MgSo4	1.0%	77 7a
	0.5%	71.3ab
	0.1%	62.8bcd
ZnSo4	1.0%	60.4bcd
	0.5%	58.6bcd
	0.1%	63.8bc
Control (NPV alone)		51.3cd

* All treatments contained NPV @ 10^4 POB/ml

@ In a column, means followed by similar letters are not different statistically (P=0.05) by DMRT

application of NPV at 125 LE + endosulfan 175 g a.i + boric acid 125 g/ha was as effective as NPV 250 LE + endosulfan 175 g a.i.ha or endosulfan at 350 g a.i./ha (Table 2). Addition of

Table 2. Field efficacy of ULV application of NPV in combination with endosulfan and boric acid in the control of *Heliothis armigera* on chickpea cv. Shoba

Treatments	Number of larvae/10 plants* days after						Mean % pod damage	Mean yield of grain in kg/ha
	First spray			Second spray				
	0 **	5	7	0 **	5	7		
NPV 250 LE/ha in 20% crude sugar	7.3	2.3b	1.3a	7.7	0.7a	1.2a	6.8a	1042.5ab
NPV 250 LE + Endosulfan 175 g a.i./ha in 20% crude sugar	10.0	2.0ab	0.3a	6.7	1.7ab	1.0a	4.3a	1248.0a
NPV 250 LE + Boric acid 125 g/ha in 20% crude sugar	11.3	2.3b	4.0b	8.3	3.0ab	2.3b	8,6a	1013.0b
NPV 125 LE + endosulfan 175 g a.i. + boric acid 125 g/ha in 20% crude sugar	9.3	1.7ab	0.7a	6.3	1.7ab	1.0a	6.6a	1014.0b
NPV 250 LE/ha	10.7	5.3c	7.7c	9.0	3 3b	3.5c	17.1b	982.5b
Endosulfan 350 g a.i./ha	11.3	1.0a	0.7a	6.7	0.7a	0.7a	5.5a	977.5b
Control	10.0	8.0d	14.7d	8.7	7.3c	5.7c	27.1c	787.0c

* In a vertical column, means followed by similar letters are not different statistically (P = 0 05) by DMRT

** Differences between the means not significant only boric acid to NPV did not improve the efficacy of the virus substantially, though the laboratory study revealed that boric acid at 1.0% enhanced the larval mortality due to NPV. The same trend was observed in the subsequent three observations. Pod damage was significantly reduced in all the treatments when compared to control. Lowest pod damage was seen in endosulfan 350 g a.i./ha which was however on par with those of NPV-endosulfan-boric acid mixture, NPV-endosulfan and NPV-boric acid combinations, as well as NPV alone with 20% crude sugar as adjuvant. Data on grain yield showed that application of NPV at 125 LE + endosulfan 175 g a.i. + boric acid 125 g/ha was as effective as NPV at 250 LE/ha or NPV 250 LE + boric acid 125 g/ha. However, application of NPV 250 LE + endosulfan 175 g a.i./ha gave the highest yield which was on par with NPV 250 LE alone applied with 20% crude sugar.

The results of this trial indicate that *H. armigera* can be successfully controlled by the CDA application of NPV at 250 LE/ha in 20% crude sugar alone or in combination with endosulfan at 175 g a.i./ha or NPV at a reduced dose of 125 LE + endosulfan 175 g a.i. + boric acid 125 g/ha. Application of NPV along with endosulfan would become necessary whenever damage by *Spodoptera exigua* (Hbn.) is noticed along with that of *H. armigera*. Boric acid is known to increase the efficacy of NPV in other insects like *Spodoptera litura* F. (Rao *et al*., 1987) and addition of boric acid to a NPV formulation enhanced its effectiveness against the gypsymoth larvae *Lymantria dispar* L. (Shapiro and Bell, 1982). Boric acid acts by weakening and predisposing the host insects to the virus rather than by enhancing the virulence of the pathogen (Aizawa, 1971). Recently, a wettable powder formulation of NPV effecive against *H. armigera* has been developed (Ethiraju *et al*., 1987) and there is scope for increasing its effectiveness by the addition of boric acid in the basic formulation.

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