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Efficacy of ULV Application of Nuclear Polyhedrosis Virus with Certain Adjuvants for the Control of *Heliothis armigera* (Hbn.) on Cotton

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ABSTRACT

Results of the field experiment on the control of *Heliothis armigera* (Hbn.) on cotton with nuclear polyhedrosis virus (NPV) revealed that four rounds of ULV application of the virus at 450 larval equivalents (LE)/ha along with endosulfan 350 g a.i./ha with adjuvants like larval extract of *H. armigera* 4 per cent or whole milk 10 per cent + crude sugar 15 per cent or cotton seed kernel powder 2.5 per cent + crude sugar 17.5 per cent were as effective as endosulfan 700g a.i./ha in reducing the larval population of *H. armigera* and damage caused to flowers, squares and bolls. The different NPV treatments applied with adjuvants significantly increased the seed cotton yield over untreated check.

Key Words : NPV Control, *Heliothis armigera,* adjuvants, larval extract, field efficacy, cotton.

During the past few years, the damage by the American bollworm *Heliothis armigera* (Hbn.) has become serious on many crops especially cotton in South India. The estimated loss in cotton in Tamil Nadu, India during 1987 - 88 was about 20 percent with a value of Rs. 6.9 crores (Jayaraj, 1988). The future of the cotton industry will depend very much on the development of suitable alternate methodsf or controlling *H. armigera* on cotton since resistance in *H. armigera* to certain pesticides like DDT and carbaryl (Collins, 1986) endosulfan, (Basson *et al.*, 1979; Wilson, 1974) monocrotophos (Whitten and Bull, 1970) and synthetic pyrethroids (Collins, 1986) has been reported. The first reported field use of NPV against *H. armigera* on cotton was by Coaker (1958) in Uganda. In attempts to achieve increased efficacy of NPV, certain adjuvants to increase wettability and adhesiveness, decrease evaporation and sunlight degradation, increase stability and act as gustatory stimulant have been used (Bell and Kanavel, 1975, 1978; Ignoffo and Montoya, 1966; Ignoffo and Batzer, 1971; Jaques 1972; Smith *et al.*, 1980; Rabindra and Jayaraj, 1987). Adjuvants were also combined with insecticides to increase the effectiveness of NPV (Ignoffo, 1966). The nuclear polyhedrosis virus has also been tested against the pest on several other crops (Jayaraj *et al.*, 1985). In the present investigation, the efficacy of NPV applied along with certain spray adjuvants in controlling *H. armigera* on cotton was evaluated.

MATERIALS AND METHODS

The nuclear polyhedrosis virus which is of a single embedded virion type (Rabindra, 1973) maintained in the Department of Entomology, Centre for Plant Protection Studies, Tamil Nadu Agricultural University was propagated in fourth instar larvae of *H. armigera*. The diseased cadavers were collected in glass distilled water, homogenized in a blender, filtered through a cheese cloth and the polyhedra separated by differential centrifugation. A double-ruled improved Neubaur haemocytometer was used to assess the number of polyhedra in the suspension. In all the field applications only fresh NPV was used.

A field experiment was conducted in a farmer's field at Kanchappali village of Coimbatore district to evaluate the efficacy of NPV applied with certain adjuvants (Table 1) against *H. armigera* on DCH 32 hybrid cotton. The plot size was 8 x 5 m with gangway of 2 m all around. The treatments were replicated thrice in a randomized block design. Cotton seed kernel powder was ground in a pestle and mortar and extracted with small quantities of water. Crude sugar was dissolved thoroughly in minimum quantity of water. For the treatment containing the larval extract, healthy final instar larvae of *H. armigera* free of NPV infection was homogenized in a pestle and mortar with minimum quantity of water. The extracts of different adjuvants were passed through a muslin, the appropriate quantity of NPV added and mixed thoroughly before spraying. The different adjuvants were selected based on earlier laboratory experiments. (R. J. Rabindra and S.Jaya-

TABLE 1. Larval population of *Heliothis armigera* in different treatments seven days after each application in DCH 32 cotton.

Treatments *	Larvae / 5 plants 7 days after spray			
	I	II	III	IV
1. NPV + cotton seed kernal powder 2.5% + crude sugar 17.5% + endosulfan 350 g a.i./ha-ULV	7.15a	5.00ab	3.30a	1.05a
2. NPV + crude sugar 20% + endosulfan 350 g a.i./ha - ULV	8.10ab	6.15bc	5.05ab	2.00a
3. NPV + *H. armigera* larval extract 4% + crude sugar 15% + endosulfan 350 g a.i./ha - ULV	7.05a	4.10a	3.00a	0.90a
4. NPV + whole milk 10% + crude sugar 15% + Endosulfan 350 g a.i./ha-ULV	7.30a	4.90a	3.33ab	1.20a
5. Endosulfan 700 g a.i./ha - ULV	8.56ab	7.70cd	6.15ab	1.00a
6. Endosulfan 700 g a.i./ha - HV	9.25b	7.90d	7.00ab	1.15a
7. NPV - ULV	12.58c	10.90e	9.00b	6.23b
8. Control	17.29d	19.22f	16.09c	12.75c

Means followed by common letters are not significantly different at 0.05%level by DMRT

* NPV @ 450 LE/ha; ULV - Ultra Low Volume, HV - High Volume.

raj, Unpub. data). The ULV application was done with a spinning disc controlled droplet applicator (Thompson Motronics, Ahmedabad, India) using No. 4 disc with a spray fluid coverage of 12.5 litres/ha. The high volume application of endosulfan was made with a knapsack sprayer using a spray fluid of 1000 litres/ha. Four sprayings were given at intervals of 10 days starting the first round 75 days after sowing when there was a high incidence of *H. armigera* larvae on the crop. Triton X 100 0.1% was added to all the treatments and the applications were made in the evening hours.

Larval pouplation was recorded at periodic intervals on ten tagged plants selected in each plot omitting the border rows. Flower, square and boll damages were recorded from the same plant. At harvest, the seed cotton yield was recorded in individual plots. The data on the larval population were converted to $\sqrt{X + 0.5}$ and the percentage values to angles and after analysis of variance, the means were separated by D. M. R. T.

RESULTS AND DISCUSSION

Larval Population

The pre-treatment count showed that the larval population ranged from 17.20 to 21.50 per 5 plants and the variations in different plots were not significant. One day after spraying, there was a significant reduction in the larval population in all the treatments except NPV applied alone. But significantly minimum larval numbers were recorded in endosulfan high volume as well as ULV sprays (Fig. 1). In the

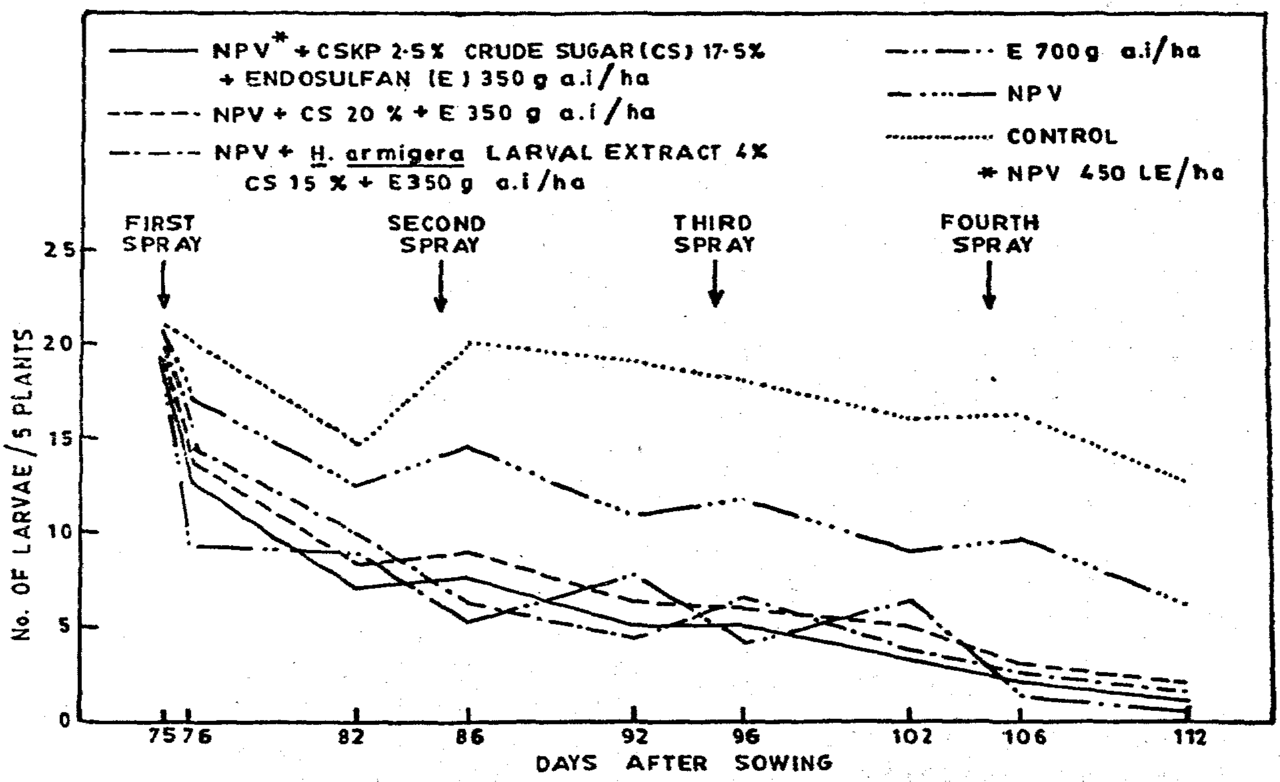

Fig. 1 Field Efficacy of ULV Application of NPV with Adjuvants on *H. armigera* Larval Population in DCH 32 Cotton

subsequent days, it was found that combinations of NPV @ 450 LE / ha containing adjuvants like crude sugar either alone or in combination with larval extract and cotton seed kernel powder (CSKP), with endosulfan 350 g a. i./ha were significantly more effective in reducing the larval number when compared to NPV applied alone. Ultra low volume application of endosulfan @ 700 g a. i./ha was also as effective as the virus-endosulfan combination treatments. Seven days after application, all the virus treatments containing the adjuvants like CSKP, *H. armigera* larval extract and milk along with half the dose of endosulfan were found to record significantly lower larval populations and were superior to ULV application of endosulfan and NPV alone (Table 1). Application of NPV alone resulted in only a marginal reduction in larval numbers. Almost a similar trend was noticed in the subsequent two observations. Data recorded on the seventh day after the fourth round, however, showed that all the NPV treatments carrying adjuvants and endosulfan were as effective as the full dose of endosulfan. Application of virus without adjuvants or endosulfan was inferior to all other treatments except control. The data also showed that there were steady reductions in the larval number after each subsequent round of application of the virus. In control also there was a reduction in the larval population in each subsequent count, but it was not so drastic as in NPV treatments.

Successful control of *H. armigera* larval population has been reported on certain crops like chickpea (Narayanan, 1979; Rabindra and Jayaraj, 1987), pigeonpea (Santharam *et al.*, 1981) and sunflower (Rabindra *et al.*, 1985). Coaker (1958) could not get adequate field control of *H. armigera* larval population on cotton. In the present investigation, very good control of larvae could be achieved and this was due to the addition of adjuvants as well as endosulfan at reduced dose to the virus. In field experiments on cotton, Ignoffo *et al.* (1965) could not get significant reduction in larval numbers but seed cotton yields could be increased significantly.

Damage to flowers, squares and bolls

Data on flower damage showed that significantly minimum damage was observed in plots receiving NPV-endosulfan combination containing *H. armigera* larval extract and crude sugar as adjuvants which was on par with NPV-endosulfan (350 g a. i./ ha) combination carrying crude sugar + CSKP or crude sugar + milk as adjuvants as well as endosulfan sprays applied at full dose of 700 g a. i./ ha. Application of NPV without adjuvants was not as effective as those treatments containing the adjuvants. Almost a similar trend was seen with regard to square damage. In the case of boll damage, it was found that all the virus treatments containing endosulfan and adjuvants were as effective as endosulfan sprayed at full dose. Even though NPV applied without adjuvants could cause significant reduction in damage to flowers, squares and bolls, it was not as effective as virus - endosulfan - adjuvant combination (Table 2).

TABLE 2. Efficacy of ULV application of NPV with certain adjuvants for the control of *H. armigera* on cotton (Mean of four observations)

Treatments *	% Damage			Seed cotton yield kg/ha
	Flower	Squares	Bolls	
1. NPV + cotton seed kernal powder 2.5% + crude sugar 17.5% + endosulfan 350 g a.i./ha - ULV	9.14ab	10.53ab	7.67a	2490a
2. NPV + crude sugar 20% + endosulfan 350 g a. i./ha ULV	10.94b	14.71b	9.86a	2420a
3. NPV + *H. armigera* larval extract 4% + crude sugar 15% + endosulfan 350 g a.i./ha - ULV	7.51a	9.11a	6.67a	2520a
4. NPV + whole milk 10% + crude sugar 15% + endosulfan 350 g a.i. /ha - ULV	7.59a	10.47ab	7.63a	2500a
5. Endosulfan 700 g a.i./ha-ULV	9.08ab	9.47a	6.78a	2518a
6. Endosulfan 700 g a.i./ha - HV	8.12a	9.11a	6.51a	2521a
7. NPV	19.84c	19.35c	14.11b	1810b
8. Control	27.32d	27.73d	21.08c	1560b

Means followed by common letters are not significantly different at 0.05% level by DMRT.
* NPV @ 450 LE/ha; ULV - Ultra Low Volume, HV - High Volume.

Reduction in damage to squares and bolls by *Heliothis zea* and *H. virescens* has been reported earlier by Ignoffo *et al.* (1965). Application of *Autographa californica* NPV (AcMNPV) applied at the rate of 8.9 x 10^{11} POB / ha along with an adjuvant has also been reported to reduce the damage to squares and bolls by *Heliothis virescens* (Bell, 1981).

Yield of Seed Cotton

Seed cotton yield was found to be significantly increased in all the treatments except NPV applied without adjuvant. All the virus treatments in combination with endosulfan and adjuvants were as effective as application of endosulfan at full dose in increasing the seed cotton yield. In some earlier reports, eventhough application of NPV could reduce larval numbers, seed cotton yields could not be increased (Ignoffo and Couch, 1987). However, addition of adjuvants to NPV could increase the efficacy of the virus and significant increases in seed cotton yield were reported in several studies (Montoya *et al.*, 1966; Ignoffo *et al.*, 1972; Yearian *et al.*, 1980). Several adjuvants like molasses (Roome, 1975), soybean, cotton seed and citrus pulp (Smith *et al.*, 1980), cotton seed flour (Hostetter *et al.*, 1982), cotton seed oil (Bell and Kanavel, 1975) and crude sugar (Rabindra and Jayaraj, 1986) were reported to be effective. *Heliothis* larval extract at 4% has been reported to be a very good adjuvant for *H. armigera* NPV (Rabindra and Jayaraj, 1987). In all these cases, the adjuvants acting as phagostimulants increased the acquisition of the virus by increased consumption of treated surface. Some of these phagostimulants might also act as UV screens and evaporation retardants. The successful control of *H. armigera* population on cotton with the resultant increase in yield of seed cotton in the present instance is also due to the combined use of virus with endosulfan. *H. armigera* has been successfully controlled by the use of a combination of NPV with reduced dose of endosulfan on chickpea (Rabindra and Jayaraj, 1987), pigeonpea (Sithanantham, 1987) and sunflower (Rabindra *et al.*, 1985).

The use of NPV + endosulfan on cotton is a sound approach. Better control of *H. armigera* could be achieved with a combination of NPV and endosulfan since the virus infection increased the susceptibility of the insect to the insecticide (Srinivas, 1987). Further, cotton being attacked by a bollworm complex, species other than *H armigera* can be controlled by endosulfan, while NPV would take care of *H. armigera*. NPV of *H. armigera* is specific and reported to be safe to several natural enemies of *H. armigera* (Anon., 1985) and since endosulfan is also known to be relatively less toxic to beneficial insects than some of the OP compounds and synthetic pyrethroids (Manoharan and Balasubramanian, 1982; Somasundaram and Reghupathy, 1985; Srinivas, 1987), the application of virus-endosulfan mixture would also be ecologically least disruptive. However, if some effective entomopathogens could be identified for bollworms like *Earias* spp. and *Pectinophora gossypiella* Saunders, the use of endosulfan can be dispensed with.

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