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Effect of Nuclear Polyhedrosis Virus Infection on the Insecticide Susceptibility of *Heliothis armigera* and *Spodoptera litura* Larvae

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ABSTRACT

Laboratory bioassay studies revealed that nuclear polyhedrosis virus infection in late stage larvae of *Heliothis armigera* and *Spodoptera litura* increased their susceptibility to insecticides. The virus infection increased the susceptibility of final instar larvae of *H. armigera* to fenvalerate, cypermethrin, endosulfan and monocrotophos. The enhanced susceptibility was maximum in cypermethrin followed by endosulfan. The susceptibility of final instar larvae of *S. litura* to fenvalerate, cypermethrin, endosulfan, phenthoate and chlorpyriphos was also substantially increased.

Key Words : NPV infection, *Heliothis armigera, Spodoptera litura,* insecticide susceptibility

The notorious polyphagous pests *Heliothis armigera* (Hbn.) and *Spodoptera litura* F. are known to have developed resistance to the commonly used insecticides (Mehrotra, 1989), with the result, it is becoming increasingly difficult to manage these pests. Fortunately, both the insects are highly susceptible to their respective nuclear polyhedrosis viruses (Rabindra and Jayaraj, 1986; Santharam, 1985) and can be successfully controlled if the application coincides with the occurrence of early stages of the larvae. It is well known that late stage larvae are more tolerant to the virus (Rabindra and Subramaniam, 1974; Santharam, 1985), but the present investigations have shown that sublethally infected late instar larvae are more susceptible to insecticides than their healthy counterparts.

MATERIALS AND METHODS

Disease-free colonies of *H. armigera* and *S. litura* were maintained in the laboratory on a semisynthetic diet (Shorey and Hale, 1965) and castor bean leaves respectively. The susceptibility of healthy and NPV infected final instar larvae of *S. litura* to chlorpyriphos, dichlorvos, phenthoate, endosulfan, fenvalerate and cypermethrin was studied by bioassay. Fifth instar larvae of uniform age and size were inoculated by oral feeding of one µl of NPV suspension to give a dose of 10^5 polyhedral occlusion bodies (POB)/larva. Half of the larvae of the same batch was maintained without virus inoculation. On the third day, both NPV-inoculated and healthy larvae reached the final instar and were bioassayed for insecticide susceptibility. The insecticides diluted to appropriate concentration with acetone were applied on the dorsal side of the larvae in one µl aliquots using a microsyringe. The larvae were provided with fresh castor bean leaves and mortality was recorded after 24h.

Fifth and sixth instar *H. armigera* larvae of uniform age and size were inoculated orally with 10^4 and 10^5 POB/larva respectively with the help of a microsyringe. Another group of larvae from the same batch without virus

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inoculation was kept as control. The larvae were then transferred back to their individual penicillin vials and on the third day, both control and NPV-inoculated larvae were bioassayed for susceptibility to fenvalerate, endosulfan, cypermethrin and monocrotophos. The fifth and sixth instar larvae had by then reached the final instar and prepupal stages respectively. The insects were topically applied with 1 μl of different concentration of the pesticides diluted with acetone. Twenty four hours after treatment, mortality counts were taken. The mortality data were converted to probits and subjected to probit analysis (Finney,1962).

RESULTS AND DISCUSSION

In all the bioassays, it was observed that the NPV-inoculated larvae of *H. armigera* and *S. litura* were more susceptible to the insecticides than their un-inoculated counterparts. The LC_{50} values were much lower in NPV-inoculated than in uninoculated larvae (Tables 1,2).

Comparison of the susceptibility ratios showed that the NPV-induced susceptibility in *H. armigera* was maximum in cypermethrin followed by endosulfan and minimum in fenvalerate. Though the prepupae were more tolerant than the larvae to fenvalerate, NPV-inoculation increased its susceptibility to the insecticide. In contrast to *H. armigera,* the virus-induced susceptibility in *S. litura* was maximum in fenvalerate followed by endosulfan and chlorpyriphos and minimum in cypermethrin.

The influence of subacute infection of polyhedrosis virus on the insecticide susceptibility has been reported in the cabbage looper *Trichoplusia ni* also by Girardeau and Mitchell (1968) who postulated that devitalization of the host by a disease may so alter its physiology, that stresses or toxins relatively minor to a healthy vigorous insect may have severe effects and even cause death in a diseased insect. Justin *et al.* (1989) have reported that *Bacillus thuringiensis* (Bactospeine[R]) also increased the

Table 1. Effect of NPV infection on the susceptibility of final instar larvae of *Heliothis armigera* to some insecticides

	NPV/ Control	No. of larvae used	df	χ^2 * (n-2)	Slope 'b'	LD_{50} (μg/larva)	Fiducial limits	Susceptibility ratio
Fenvalerate (final instar)	NPV	120	2	3.57	2.53	0.0374	0.0288-0.0474	2.02
	Control	120	2	4.33	2.76	0.0757	0.0596-0.0945	
Fenvalerate (Prepupa)	NPV	96	2	2.31	2.80	0.0708	0.0537-0.0905	2.06
	Control	96	2	0.08	3.1	0.1460	0.1142-0.1839	
Endosulfan (final instar)	NPV	147	3	1.98	1.91	3.7886	2.5819-4.9937	4.46
	Control	150	3	2.99	2.36	16.8901	13.3494-21.6265	
Cypermethrin (final instar)	NPV	160	3	1.97	1.94	0.1690	0.1249-0.2197	5.82
	Control	160	3	1.81	1.68	0.9832	0.7228-1.3323	
Monocrotophos (final instar)	NPV	150	3	0.37	1.20	3.4015	1.3439-4.4286	3.32
	Control	150	3	3.20	2.95	11.3040	9.1963-13.4254	

* All lines are significantly a good fit ($P < 0.05$)

Table 2. Effect of NPV infection on the susceptibility of final instar larvae of *Spodoptera litura* to some insecticides

	NPV/ Control	No. of larvae used	df	χ^2 * (n-2)	Slope 'b'	LD_{50} (µg/larva)	Fiducial limits (95%)	Susceptibility ratio
Fenvalerate	NPV	150	3	2.03	1.70	0.0713	0.0478-0.0967	8.79
	Control	180	4	0.51	1.80	0.6264	0.4704-0.8251	
Phenthoate	NPV	150	3	5.44	2.06	7.8771	5.9573-10.1492	2.28
	Control	150	3	2.75	2.92	17.9227	13.9086-21.5286	
Dichlorvos	NPV	150	3	1.95	2.08	8.0083	6.0745-10.3388	1.62
	Control	150	3	2.81	2.20	12.9603	10.1165-16.9676	
Chlorpyriphos	NPV	150.	3	0.53	2.26	0.7385	0.5656-0.9372	3.06
	Control	150	3	0.26	3.52	0.2588	2.6244-1.8915	
Endosulfan	NPV	150	3	4.32	3.05	11.6148	9.3273-13.9861	3.37
	Control	180	4	1.04	13.76	39.0994	37.6447-40.5225	
Cypermethrin	NPV	144	4	6.21	3.90	0.7670	0.6537-0.8833	1.51
	Control	122	3	2.32	6.91	1.1598	1.0534-1.3042	

* All lines are significantly a good fit ($P < 0.05$)

susceptibility of *H. armigera* and *S. litura* larvae to insecticides. Increased insecticidal susceptibility due to protozoan infection has been reported in coleopteran insects like the American boll weevil, *Anthonomus grandis* (Bell and McLaughlin, 1970) and the flour beetles, *Tribolium confusum, T. destructor* (Listov and Nesterov, 1976) and *T. castaneum* (Rabindra *et al.*, 1988).

Oxidative metabolism of cyclodien compounds occur in fat body as reported in larvae of *Heliothis zea* and *Spodoptera eridania* (Krieger and Wilkinson, 1969). Mixed function oxidases responsible for breakdown of monocrotophos was detected in fat body of *Spodoptera littoralis* (Dittrich *et al.*, 1980) and *Heliothis virescens* (Bull and Whitten, 1972). Esterases responsible for breakdown of synthetic pyrethroids have been found in the hypodermis and fat body in *S. littoralis* (Abdel-Aal and Soderbund, 1980). It is known that NPV infects the vital organs like the fat body, blood cells and hypodermis apart from other organs. It may be postulated that infection of fat body, blood cells and hypodermis by the virus should have played a major role in the increased susceptibility of the larvae to the different insecticides.

The present findings are of immense importance in the context of insecticide resistance reported in both *H. armigera* and *S. litura*. Resistance in *S. litura* to endosulfan, carbaryl and malathion (Verma *et al.*, 1971; Ramakrishnan *et al.*, 1974) and *H. armigera* to cypermethrin (Dhingra *et al.*, 1988; Phoekela *et al.*, 1989) and other pyrethroids (McCaffery *et al.*, 1988; 1989) have been reported in India. Our findings, as well as other reports cited indicate that by properly integrating the use of NPV in the pest management programmes, both *H. armigera* and *S. litura* may be successfully controlled with optimum doses of chemical insecticides. The viruses may be applied alternatively or used in combination with chemical insecticides, thereby playing an important role in insecticide resistance management, as microbial infection can break insecticide- resistance in host insects (Listov and Nesterov, 1976).

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