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Studies on the Transmission of Nuclear Polyhedrosis Virus of *Spodoptera litura* (Fabricius) to its Progenies

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ABSTRACT

The transmission of a nuclear polyhedrosis virus (NPV) from generation to generation was studied in *Spodoptera litura* (F.). NPV-infected adults were produced by feeding 5th instar larvae with sub-normal concentration of NPV. Egg and larval mortality was observed in the progeny from infected adults, the transmission being transovum and transovarial. The healthy adults were able to transmit the NPV to their progeny by egg surface coating when fed with NPV orally, more so when both the sexes were fed. The larval mortality was more in the case of eggs laid on the first day and declined in the case of second and third day laid eggs.

KEY WORDS: *Spodoptera litura*, Nuclear polyhedrosis virus, transmission, transovum, transovarial.

The transmission of nuclear polyhedrosis virus (NPV) from generation to generation enables its persistence in nature. The virus may be transmitted either by virus contaminated egg surface or by transovarian infection (Steinhaus, 1954; Bergold, 1958). Elmore and Howland (1964) found that the adults of *Trichoplusia ni* (Hubner) transmitted the NPV when fed orally. Young and Yearian (1982) reported that the infected adults of *Pseudoplusia includens* (Wlk.) transmitted the virus. In the present study attempts were made to study the mode of transmission of a NPV and its efficiency in causing mortality in the progeny of *S. litura*.

MATERIALS AND METHODS

The experiments were conducted with a healthy colony of *S. litura* maintained in the laboratory on castor leaves.

Adult infection

Larvae of fifth instar, a day after moulting, were fed on castor leaves treated with NPV at 5 x 10^6 polyhedral occlusion bodies (POB) / ml 10^6. The resultant pupae were sexed and kept in separate containers for adult emergence. Five pairs of apparently normal and active moths were selected and confined for mating and egg laying in a container. The eggs laid on the second day were collected and kept in two batches, one after surface disinfection with 10 per cent formalin and the other without any treatment. Simultaneously, eggs obtained from healthy moths were kept separately to serve as check. The hatched out larvae were reared on castor leaves. Egg hatchability and instar-wise larval mortality due to NPV were recorded by daily observations. The body fluid of moths used in the experiment was examined individually after the egg collection under a phase contrast microscope for the presence of POB to confirm the adult infection.

Adult feeding

Normal and active moths obtained from a healthy colony were selected and pre-conditioned by starving for 24 h. The sexes were kept separately until they were fed with NPV at 10^8 POB/ml mixed with 10 percent honey in a transparent plastic container (4 cm dia x 5 cm height). The plastic container with 2 ml of NPV-honey mixture was kept inclined at about 45° angle and the moths were induced to feed by gentle tapping of the container. The moths that actively siphoned the inoculum and without contaminating their abdomen alone were selected.

The experiment was conducted in three combinations of treatments : (i) male moths fed with NPV, (ii) female moths fed with NPV and (iii) both the sexes fed with NPV. Five pairs per combination were allowed to mate and lay eggs. Simultaneously a set of 5 pairs of healthy moths fed with 10 per cent honey were maintained as check. Eggs obtained from each combination were divided into two sets, one was surface disinfected with 10 per cent formalin and the other without any treatment. The eggs were collected for first three days and eggs from each day were kept separately for hatching . After hatching, the larvae

TABLE 1. Egg and larval mortality of the F_1 generation from infected adults

	Egg treatment	Egg	$\bar{x}$ Mortality (%) (N=5) Larval instars**						$\bar{x}$ % (Larval mortality)	Total
			I	II	III	IV	V	VI		
1.	Not surface disinfected	20.0	40.0	10.0	8.0	6.4	6.4	3.2	12.3^a	94.0
2.	Surface disinfected	19.7	9.2	10.4	8.0	10.8	8.0	4.8	8.5^b	70.9
3.	Mean		24.6^a	10.2^b	8.0^d	8.6^c	7.2^e	4.0^f		

Figures followed by same letter in the horizontal/vertical column are not significantly different by LSD (P = 0.01)

were reared on castor leaves. Observations on egg hatchability and larval mortality were recorded daily until pupation. The body fluid of the moths used in the experiment was examined for the presence of NPV as described earlier. The data on larval mortality were transformed to $\sqrt{P+0.5}$ (P=Per cent mortality) and analysed as per the method described by Panse and Sukathme (1967).

RESULTS AND DISCUSSION

Adult Infection

Feeding fifth instar larvae with sub-normal concentration of NPV at 5 x 10^6 POB/ml resulted in 40 per cent adults and all of them were infected as was evidenced by the presence of NPV in the body fluid of the moths used in the experiment. Smirnoff (1962) reported that weak concentrations of a NPV were non-fatal for larvae of older instars of *Neodiprion swainei* Middleton and 60 per cent of them developed into normal imagoes and retained the infection. Similarly. Young and Yearian (1982) found that the treatment of sixth stage larvae of *P. includens* with NPV resulted in infected adults.

The hatchability of eggs laid by the infected moths was reduced by about 20 per cent (Table 1) whether surface disinfected or not which may be due to the transovarial transmission of the virus in which the virus killed the developing embryo. Smith (1967) observed polyhedra within the eggs of *Mamestra brassicae* (L.) that failed to hatch. Abul-Nasr *et al.* (1979) found in the cotton leafworm, *Sodoptera littoralis* (Boisd.) that the rate of unhatched eggs was significantly higher in the eggs laid by NPV-survivor females. Similar reduced egg viability in *P. includens* following NPV treatment of sixth stage larvae was reported by Young and Yearian (1982).

Significantly higher mortality or larvae was observed when the eggs were not surface disinfected than those eggs that were disinfected (Table 1). The mortality among the instars also differed significantly, maximum being in the first instar and as the larvae grew, the mortality declined significantly. High larval mortality (74 per cent) was observed when the eggs were not surface disinfected compared to 51.2 per cent in the surface disinfected eggs. When the instar-wise mortality of larvae was considered, it was maximum (40 percent) in the first instar when the eggs were not surface disinfected and minimum (9.2 per cent) in the surface-disinfected eggs. The increased mortality may be due to the coating of egg surfaces also with the virus which might have been ingested along with the chorion by the neonate larvae. The mortality of first instar larvae of the surface disinfected eggs is due to the virus transmitted through the egg. Mortalities were observed in all the instars in both surface-disinfected and non-disinfected eggs. When the total egg and larval mortalities were considered together, it was 94 per cent in the eggs that were not surface-disinfected and 70.9 per cent in the eggs that were surface disinfected (Table 1). Similar results of larval mortality of the progeny from infected adults were reported in *Spodoptera litura* (Pawar and Ramakrishnan, 1971) *S. littoralis* (Abdul-Nasr *et al.*,1979), *Mythimna separata* (Wlk.) (Neelgund and Mathad, 1978) and *Spodoptera mauritia* (Boisd.) (Nair and Jacob, 1985).

Adult Feeding

The results (Table 2a, b, c) indicated that the moths fed with NPV were able to transmit the virus to their progenies only by contaminating the egg surface as there was no mortality in the surface-disinfected eggs. Hamm and Young (1974)

TABLE 2. Larval mortality (%) of F_1 generation fed with NPV (Mean of 3 observations)

TABLE 2a From first day laid eggs

	Treatments (moths fed with NPV)	Instar							Total
		I	II	III	IV	V	VI	Mean	
1.	Male fed x Female not fed	14.0	7.3	6.7	3.3	3.3	0.7	6.4^{c}	35.3
2.	Male not fed x Female fed	20.7	12.0	5.3	4.0	2.0	1.3	7.6^{b}	45.3
3.	Male fed x Female fed	30.0	12.0	7.3	6.0	3.3	0.7	9.9^{a}	59.3
4.	Check	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mean	17.0^{a}	7.8^{b}	4.8^{b}	3.3^{d}	2.2^{e}	0.7^{f}		

TABLE 2b From second day laid eggs

1.	Male fed x Female not fed	12.7	6.7	2.7	2.0	1.3	0.0	4.2^{b}	25.4
2.	Male not fed x Female fed	22.7	7.3	2.0	2.7	1.3	0.7	6.1^{ab}	36.7
3.	Male fed x Female fed	25.3	8.7	4.7	3.3	2.0	0.0	7.3^{a}	44.0
4.	Check	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mean	15.2^{a}	5.7^{b}	2.3^{c}	2.0^{c}	1.2^{d}	0.2^{e}		

TABLE 2c From third day laid eggs

1.	Male fed x Female not fed	5.3	2.7	1.3	0.7	1.3	0.7	2.0^{c}	12.0
2.	Male not fed x Female fed	10.0	4.0	2.0	0.7	1.3	0.7	3.1^{b}	18.7
3.	Male fed x Female fed	16.0	5.3	2.7	2.0	1.3	0.7	4.7^{a}	28.0
4.	Check	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		7.8^{a}	3.0^{b}	1.5^{c}	0.8^{d}	1.0^{d}	0.5^{e}		

reported that the NPV of *Heliothis zea* (Boddie) was transmitted by surface contamination of the eggs with the POB that had passed through the digestive tract of adults that had been fed with the POB. Similar transmission of virus by adult feeding was reported by Neelgund and Mathad (1978) and Elnagar *et al.* (1982)

When both sexes were fed with the virus the mortality was maximum and it ranged from 59.3 to 28 per cent in the eggs laid in three days as more NPV might have been coated on the chorion than when either sex was fed with NPV. When the female alone was fed, the mortality was less (45.3 to 18.7%) but it was lower when the males alone were fed with the virus (35.3 to 12.0%). This may be due to the fact that female moths were able to pass more NPV than males to the eggs. The NPV gets coated to the egg surface from the anal region or from the abdominal tip when the moth lays eggs. But in the case of males fed with the NPV, the virus had to be transmitted first to the female while mating and then passed on to the egg surface. So the eggs get the inoculum only via females in which case there is every likelihood of dilution of the virus.

Maximum mortality was observed only in the first instar larvae. This showed that large number of larvae acquired a lethal dose of the virus as the quantity of virus required to kill the larvae was less because of small body weight. The reduced mortality observed in all the subsequent instars may be due to the ingestion of lesser inoculum by the hatching larvae from the chorion.

The rate of mortality declined in the larvae developing from the second day laid eggs and still further from the third day eggs. This may be due to the physical loss of virus as more virus is coated on the eggs laid on the first day. Similar decline in virus-induced mortality of the progeny

of virus contaminated females in *M. brassicae* was reported by Tatchell (1981).

The above results indicate that in the adult infection method, the transmission was both transovarian and trasovum and in the adult feeding it was transovum only. These two methods can be used to introduce the NPV in the ecosystem and the infected adults can serve as flying reservoirs of inoculum which can make possible the spread of the pathogen over a wide area. This will also result in the initiation of epizootics. The natural epizootics observed by Dhandapani *et al.* (1982) in *S. litura* might be due to such a transmission through infected adults. Added to this, the infected adults and also NPV-fed adults have the advantage of avoiding the inactivation of the virus by sunlight and other environmental factors.

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