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Effectiveness of SlNPV of *Spodoptera litura* (Fab.) (Lepidoptera: Noctuidae) on different host plants

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ABSTRACT

Various bioassay methods were employed to screen SlNPV against *S. litura* on different host plants. In the first experiment *S. litura* larvae were reared on different host plants and when they completed second instar, they were transferred to semi-synthetic diet which was treated with different doses of SlNPV. The LC_{50} value against the pest which was reared on different host plants were as follows: cabbage 0.42, cotton 0.61, potato 0.75, groundnut 0.93 and rose 1.28 POB/mm^2. In the second experiment, larvae of *S. litura* were reared on semi-synthetic diet up to second instar and subsequently they were fed on different host plants, which were treated with SlNPV. The LC_{50} value was highest in rose (1.81) followed by groundnut, potato, cotton and cabbage (0.40 POB/mm^2). In the third experiment, larvae of *S. litura* were reared on different host plants till they complete second instar and they were screened against SlNPV in the laboratory using leaf disc method. The LC_{50} value was highest in rose followed by groundnut, potato, cotton and cabbage (1.02 POB/mm^2). In the above three experiments, the LC_{50} value was lowest in cabbage and was highest in rose.

Key words: Host plants, nuclear polyhedrosis virus, *Spodoptera litura*

INTRODUCTION

Spodoptera litura (F.) (Lepidoptera: Noctuidae), commonly known as tobacco caterpillar in India is a major polyphagous pest attacks variety of economically important crops such as cotton, groundnut, rice, tomato, tobacco, citrus, cocoa, potato, rubber, castor, millets, sorghum, maize and many other vegetables (Hill, 1993). Caterpillars of the pest defoliate the crops. The pest occurs in India, Pakistan, Bangladesh, Sri Lanka, S. E. Asia, China, Korea, Japan, Philippines, Indonesia, Australia, Pacific Islands, Hawaii and Fiji (Hill, 1993).

In various species of lepidopteran pest management, increasing failures of chemical pesticides and the problems posed by their indiscriminate use in the field have created a momentum to develop environment friendly methods of pest control. Among the alternatives that are currently available is the use of insect viruses remain the most promising, considering the fact that they can be used in a manner similar to the familiar chemical pesticides. Unlike other natural enemies, insect viruses can be produced and stored and made available to the farmers at short notice due to their longer shelf life. Of the various insect viruses, nucleopolyhedroviruses (NPV) are more successful in pest management (Roberts *et al*., 1991). *Spodoptera litura* has already developed resistance to several organic pesticides resulting severe crop losses (Singh and Singh, 1998). Fortunately, the pest is highly susceptible to its NPV and studies have shown that the virus can be used effectively as biopesticide in the field (Jayaraj *et al*., 1980). *Spodoptera litura* nucleopolyhedrovirus (SlNPV) is the most promising control agent and its efficacy has been established successfully against the pest in India (Jayaraj and Rabindra, 1990; Muthuswami *et al*., 1993). Considering the reliability, suitability and effectiveness of SlNPV in terms of economic and ecological reasons, its utilization in pest management has received a great deal of significance.

Although SlNPV has been found very effective against *S. litura*, greater amount of variation in the efficacy of SlNPV across the host plants hindered its practical utility in the field condition as reported in other lepidopteron pests (Young *et al*., 1976; Felton *et al*., 1987; Felton and Duffey, 1990; Keating *et al*., 1988; Rabindra *et al*., 1994). Variable efficacy of SlNPV and mortality of *S. litura* larvae on different host plants may be related to the secondary metabolites, enzymes, and pH of host plants. Keeping these challenges in mind the preliminary investigations were undertaken to understand the effectiveness of SlNPV against *S. litura* on different host plants.

MATERIALS AND METHODS

Disease-free colonies of *S. litura* were maintained on semi-synthetic diet following the method of Shorey and Hale (1965). In the first experiment, to understand the effectiveness of SlNPV on *S. litura* larvae, which were reared on different host plants and to avoid the direct contact between host plants and SlNPV, fresh larvae of *S. litura* from the laboratory culture on semi-synthetic diet were reared on different pot cultured host plants such as cabbage, cotton, groundnut, potato, and rose in the green house. The newly emerged female and male moth from these cultures were paired and caged separately for egg laying. When the eggs hatched the second generation neonate larvae were transferred to the respective host plants and reared up to the end of second instar. When they reached third instar, the larvae of uniform size were selected and introduced singly into vial containing semi-synthetic diet. SlNPV was assayed against these larvae on semi-synthetic diet by adopting diet surface contamination method in the laboratory following the earlier procedure (Ignoffo, 1966).

In the second experiment, to understand the effect of host plants on SlNPV efficacy by direct contact, lab cultured uniform sized fresh third instar larvae of *S. litura* on semi-synthetic were selected and fed individually with fresh leaf discs (5 mm diameter) of various host plants treated with SlNPV for one day in the laboratory. Subsequently, the treated larvae were provided respective fresh leaves (without SlNPV) at every 24hrs. In the third experiment, to understand the interaction between host plants (direct contact, host plant secondary metabolites, enzymes, pH) and SlNPV, fresh larvae of *S. litura* were reared on different host plants. The newly emerged adults were paired and caged separately for egg laying. When the eggs hatched neonate larvae of second generation were transferred to the respective pot cultured host plants and reared up to the end of second instar. When they reached third instar, the larvae of uniform size were selected and reared on fresh leaf discs of different host plants treated with SlNPV. In all the above experiments, to force the larvae to ingest the SlNPV treated food, they were kept starved for 2 hr before assaying SlNPV as followed earlier (Trang and Chaudhari, 2002). In the above experiments, the larvae reared on respective host plants without treatment of SlNPV were maintained as control. For each treatment, there were three replications with ten larvae per replication. Bioassy of SlNPV at different concentrations (1×10^6, 2×10^5, 4×10^4, 8×10^3, 1.6×10^3, 3.2×10^2) was conducted. LC_{50} of SlNPV was assessed using Probit analysis (Finney, 1952).

RESULTS AND DISCUSSION

Tobacco caterpillar, *Spodoptera litura* is one of the important agricultural pests. The effect of several control approaches, i.e. chemical control, frequency trembler grid lamps and pheromone traps, the methods based on plant attractiveness and repellency, transgenic plant, and biological control, was studied in order to reduce the population of *S. litura*. Chemical control made a great contribution to suppressing occurrence of *S. litura* and reducing its damage. *Spodoptera litura* larvae reared on different host plants and subsequently fed with semi-synthetic diet treated with SlNPV showed significant variations in virulence ($P<0.05$). LC_{50} values with respect to different host plants ranged from 0.42 to 1.28 POB per mm^2. The highest LC_{50} value was recorded in rose and the lowest was in cabbage (Table 1). Bioassay of SlNPV using early third instar larvae of *S. litura* reared on semi-synthetic diet and subsequently fed with SlNPV treated leaf discs of various host plants showed significant variations in virulence ($P<0.05$). LC_{50} values in different host plants ranged from 0.40 to 1.81 POB per mm^2. The highest LC_{50} value was recorded in rose and the lowest was in cabbage (Table 2). Bioassay of SlNPV using early third instar larvae of *S. litura* reared on different host plants and subsequently fed with SlNPV treated leaf discs of various host plants showed significant variations in virulence ($P<0.05$). LC_{50} values in relation to various host plants ranged from 1.02 to 19.50 POB per mm^2. Again the highest LC_{50} value was recorded in rose and the lowest was in cabbage (Table 3). In the above experiments, the increasing larval mortality was noticed from fourth to tenth day after treatment. Moreover, the larval mortality was also increased with increasing concentrations of SlNPV irrespective of the host plants.

Table 1. *Spodoptera litura* reared on different host plants and assayed against SlNPV on semi-synthetic diet.

Host plants	x^2*(n-2)	Slope'b'± S.E	LC_{50}(POB/mm^2)	Fiducial limits		LC_{99}(POB/mm^2)
				Lower	Upper	
Cabbage	0.51	0.86 ± 0.10	0.42	0.22	0.76	201.65
Cotton	0.75	0.92 ± 0.11	0.61	0.34	1.09	199.64
Potato	1.80	0.73 ± 0.09	0.75	0.38	1.49	1124.63
Groundnut	0.15	0.72 ± 0.09	0.93	0.47	1.87	1459.69
Rose	0.48	0.66 ± 0.09	1.28	0.62	2.80	4028.39

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

Table 2. *Spodoptera litura* reared on semi-synthetic diet and assayed against SlNPV on different host plants.

Host plants	x^2*(n-2)	Slope'b'±S.E	LC_{50}(POB/mm^2)	Fiducial limits		LC_{99}(POB/mm^2)
				Lower	Upper	
Cabbage	0.40	0.70 ± 0.09	0.40	0.19	0.81	848.87
Cotton	0.47	0.71 ± 0.09	0.81	0.40	1.64	1501.96
Potato	1.69	0.55 ± 0.08	0.94	0.40	2.31	14136.66
Groundnut	0.22	0.70 ± 0.09	1.36	0.68	2.86	2784.34
Rose	0.84	0.63 ± 0.09	1.81	0.86	4.25	8136.75

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

Table 3. Effectiveness of SlNPV against *S.litura* on different host plants.

Host plants	x^2*(n-2)	Slope'b'±S.E	LC_{50}(POB/mm^2)	Fiducial limits		LC_{99}(POB/mm^2)
				Lower	Upper	
Cabbage	0.84	0.60 ± 0.09	1.02	0.47	2.33	6768.36
Cotton	0.44	0.62 ± 0.09	2.27	1.07	5.56	11495.64
Potato	0.14	0.48 ± 0.08	4.48	1.72	17.60	255101.49
Groundnut	0.88	0.46 ± 0.08	8.14	2.83	44.60	865931.08
Rose	0.23	0.35 ± 0.08	19.50	4.58	443.06	61947027.97

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

The results of all the experiments conducted to know the influence of host plants on the effectiveness of SlNPV against *S. litura* larvae revealed that there was a significant variation in the LC_{50} values among different host plants and it was lowest in cabbage and highest in rose. Similarly, LC_{50} values of SlNPV screened against *S. litura* varied in different host plants (Kulkarni, 1997). It is known that the leaf exudates from glandular hairs of the cotton plants inactivate the NPV of *Heliothis* spp. (Falcon, 1971 and Young and Yearin, 1974). Further, it is reported that plants mediate interactions between insect and its pathogens, which increase or decrease the impact of the insect pathogen (Rabindra *et al.*, 1994; Meade *et al.*, 1995). From the present experiments it could be made out that different host plants influence the effectiveness of SlNPV by direct or indirect means. Further investigations on the leaf pH and secondary metabolites of different host plants may provide what are the factors interfere with the virulence of SlNPV. Eight of baculoviruses genes help the virus overcome insect defenses (Suzanne M. Thiem, 2009).

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