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EFFECT OF HOST PLANT LIFE ON THE EFFICIENCY OF NUCLEOPOLYHEDROVIRUS OF MAJOR POLYPHAGOUS NUISANCE SPODOPTERA LITURA (F.) (LEPIDOPTERA: NOCTUIDAE)

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Abstract

The Oriental leaf trojan horse moth, Spodoptera litura (F.) (Lepidoptera: Noctuidae), is a number of the maximum voracious insect pests in a variety of economically critical plants, mainly cotton. It has developed resistance in opposition to traditional chemical pesticides. therefore, it's miles essential to evaluate an integrated utility of bio- and artificial pesticide in opposition to this pest. Nuclear polyhedrosis virus (NPV) may be a mighty alternative to control this pest. the present examine changed into conducted to assess the efficacy of NPV and emamectin benzoate (Proclaim® 19EC) towards 3 geographically wonderful populations of S. litura in vitro situations. 2d and fourth larval instars were dealt with by 3 unique concentrations of NPV (NPV-1 2 × 109, NPV-2 three × 109, and NPV-3 four × 109 POB ml−1) and emamectin benzoate (EB 0.1 ppm) alone and in mixture. The effects showed that the highest mortality price (eighty-three.28%) became recorded for NPV-three + EB, accompanied by means of NPV-2 + EB, NPV-1 + EB, EB, NPV-three, NPV-2, and NPV-3 at all the tests. furthermore, Faisalabad (FSD) population turned into located greater susceptible, followed with the aid of Layyah (LY) and Multan (ML) populations. discount in pupation, adult emergence and egg eclosion changed into located directly related to the pathogenicity of the carried-out pathogens. The outcomes of this study discovered that biorational control of S. litura with mixed software of NPV + emamectin benzoate turned into a powerful tool.

Keywords: Spodoptera Litura, Geographically, Insecticides, Application, Degradation.

1. INTRODUCTION

In recent years, it has assumed such a serious proportion in India that for the past one-decade farmers and plant protection community have been virtually driven made by this monstrous pest S. litura, creating an array of social, economic and political problems leading to several suicidal deaths in Southern and Western regions. Although, nearly 30% of total insecticides are used for controlling this pest alone on different crops, yet many of them do not prove effective as the pest is reported to have developed resistance to almost all kinds of insecticides to varying folds (Arms et al. 1996; Yaqoob et al. 2006). This is resulting into build-up of minor pests into major pests and environmental degradation. Transgenic plants having Bt and other genes at one stage appeared to be the answer to all problems posed by this pest in different countries. But, before such plants could reach the field from laboratories, the insect may develop resistance to them (Tabashnik et al. 2003). Therefore, the demand in the present-day scenario is the formulation of some eco-friendly means of pest suppression to minimize pesticide related problems.

However, pesticide resistance, resurgence of target organism or emergence of target organism or emergence of secondary pests to major pest status, destitution of parasitoids and predators, impact on non-target organisms, poisoning of humans, environmental pollution through the accumulation of pesticides in soil and water, residues in the agricultural products have necessitated the development of more selective control methods compatible with the environment. Moreover, legislation now and in the future will limit or eliminate many chemical pesticides because of the aforementioned drawbacks (Falcon 197l).

Spodoptera litura has already developed resistance to several organic pesticides resulting severe crop losses. Fortunately, the pest is highly susceptible to its nucleopolyhedrovirus and has established history of use as an effective biopesticide and it can be applied to crops using conventional equipments designed for chemical insecticides. The NPV has been considered as a viable alternative to chemical insecticides (Moscardi 1999). As a result, Government of India has been popularizing Integrated Pest Management (IPM) for promoting biological control method using NPV as one of the important tools in the management of the pest.

Three factors that influence the use and performance of the viruses are production, biological activity (virulence), and persistence (Shapiro and Robertson 1992). Persistence generally refers to the ability of the pathogen to remain in the environment in an active state. Being obligate pathogen NPV cannot multiply without host insect and it should remain in an active state before they come in contact with the viable host (Jacques 1985). Hence, this aspect has received a wide spread attention. The factors that influence virus persistence are environmental factors (solar radiation/UV light, temperature, moisture and pH) and substrate effects (foliage factors, host plants, soil, water and host insect). Problems that have limited the expansion of baculovirus use include narrow host range, technical and economic difficulties for in vitro commercial production, need of frequent application based on the host

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population build up, variability of field efficacy due to climatic conditions, and farmers dependency on fast-killing chemical insecticides (Moscardi 1999). Further, the relatively slow speed with which baculoviruses kill their hosts has hampered their effectiveness as well as acceptance by potential users (Battu et al. 2002). Strategies to counteract some of the limitations of baculoviruses have been investigated and are promising. 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; Mutheswami et al. 1993). Considering the reliability and suitability of SlNPV in terms of economic and ecological reasons, its utilization in pest management has received a great deal of significance.

2. Review of Literature

2.1 Nuclear Polyhedrosis Virus

Insect virus belonging to family Baculoviridae differ from that of plant and animal viruses where the infective viruses are occluded on many sided poly occlusion bodies (POB) which are made of proteinaceous-silicaceous framework, which provides environmental stability to the viruses against certain external environmental factors like temperature, and UV radiation (Morris 1971). Based on the presence or absence of inclusion, site of multiplication (either at cell nucleus or cytoplasm) and shape, insect viruses are generally classified as Nuclear Polyhedrosis Virus (NPV) and Cytoplasmic Polyhedrosis Virus (CPV) (Mathad and Neelgund 1973a and 1973b).

Baculoviruses are diverse groups of large viruses with covalently closed double stranded DNA genomes of 88-153 kilo base pairs (Kbp) (Burges 1977). Molecular weight ranges from 50 x 106 Daltons. Since the virions of NPV of S. litura is rod shaped, it is a baculovirus and was named as Baculovirus Spodoptera (Adams and Bonami 1991).

More than 520 NPVs have been identified in insects (Martignoni and Iwai 1986). The families of insects in which NPVs have been found include many pests of economic importance. Many NPVs appear to be specific for the families or the genera from which they are isolated. Because of the specificity, NPVs are ideal microbial candidates for use in an integrated pest management program (Adams and Bonami l99l).

The host range of NPV is generally regarded as being restricted, but a few detailed host range studies have revealed that the host range of NPV's appear to vary from relatively wide to apparently nonspecific. The occurrence S. Iitura nuclear polyhedrosis virus in the laboratory culture was first reported by Ramakrishnan and Tiwari (1969).

2.1.1. Spodoptera litura nuclear polyhedrosis virus (SlNPV)

The NPV of S. litura has been used for the management of this pest during the last few decades with encouraging results (Sachithanandam 1988; Yi and Li 1989). A nuclear polyhedrosis virus (NPV) was reported to infect S. litura by Ramakrishna and Tiwari (1969). The SlNPV has emerged as an alternative to chemical insecticides used in the management of S. litura and is effective in several crop ecosystems (Jayaraj and Rabindra 1990; Mutheswami et al. 1993). Mass production of the virus at reasonable costs is an important factor in its development into a marketable product (Ignoffo 1913; Smits and Valak 1998). Only the in vivo production of the baculoviruses has so far been economically viable due to the high cost involved in the in vitro production systems (Kumar et al. 2005; Shieh 1989).

Optimal production of the viruses is the one that results in the greatest yield of biologically active virus and that confirms to the quality control standards (Shapiro 1982, 1986). Several factors like the type of host insect, its biology and behaviour, age, stage and sex of the larvae used for virus production; the rearing environment greatly influences the production and the quality of the virus produced (Shapiro 1982, 1986; Shapiro et a1. 1981). In general, any factor that influences the larval growth rate after virus inoculation will influence the virus yield (Shapiro 1982). The age of larvae at inoculation, virus dose and incubation temperature significantly influence the larval growth and hence the virus productivity (Carter 1984; Cherry et al. 1997; lm et a1. 1990).

Effects of SpltMNPV on survival, development, and fecundity of S. litura adults and their progeny were investigated (Bin et al. 2011).

2.1.2. Virulence of NPV isolates

The term geographic isolate recently has come into common usage and refers to the occurrence of a baculovirus in the same host collected from different geographic sites. Variations can, occur both within and between geographic isolates (Mclntosh et al. 1987). NPV that infect S. litura have been isolated from several Asian locations, including Japan (Hunter-Fujita et al. 1998). One

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Japanese isolate of S. litura NPV (SpltNPV) has been tested for controlling S. litura larval populations and is recognized as a potential alternative for the management of this insect (Okada 1977).

Restriction endonuclease (REN) analysis demonstrated that out of the 189 SpItNPV clones collected from Japan exhibited 33 distinct REN pattern that represented three different NPV types designated as type A, type B and type C SpltNPVs based on the similarity of overall REN patterns (Kamiya et al. 2004). Comparative studies from the REN pattern from the clones in the study with those from NPV published previously indicated that type A SpltNPV corresponded to S. littoralis (Boisduval) NPV(S/NPV)-D or (SAIPV)-B, type B SpltNPV corresponded to NPVs widely identified in S. litura in Japan, China and the Philippines. The overall REN pattern of the type C SpltNPV did not resemble the REN patterns from any of those NPVs previously identified in S. litura and S. littoralis (Kamiya et al. 2004)

3. Materials and Methods

The materials used and the methods employed in the investigations on influence of different host plants on the virulence of SlNPV, interactions between biochemical components of host plants and SlNPV and field trials with SlNPV against Spodoptera culture on different crops are described here.

3.1 Effect of host plants on SlNPV without direct contact:

Bioassay procedure

Disease-free colony of S. litura was maintained on semi-synthetic diet in the laboratory. In the first experiment, to understand the influence of various host plants on SlNPV efficacy against S. litura larvae without directly coming into contact, freshly hatched larvae of S. litura from the laboratory culture were reared on different pot cultured host plants such as Arachis hypogaea L. (groundnut), Brassica oleracea L. (cabbage), Gossypium hirsutum L. (cotton), Rosa indica L. (rose) and Solanum tuberosum L. (potato) in the green house. The newly emerged female and male moths of S. litura from these cultures were paired and caged separately for egg laying. When these 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 (6x25cm) containing semi-synthetic diet, which was treated with SlNPV by diet surface contamination method following the procedure of Ignoffo (1966). The mortality of the larvae was recorded at 24 hrs intervals after treatment till tenth day.

Observations were made on larval mortality at 24 h intervals from second to tenth day to establish LC_{50} and LT_{50} values.

3.2 Effect of host plants on SlNPV by direct contact

In the second experiment, to understand the effect of host plants on SlNPV efficacy by direct contact, uniform sized fresh third instar larvae of S. litura reared on semi-synthetic diet were selected and fed separately on SlNPV treated fresh leaf discs (5mm diameter) of cabbage, cotton, groundnut, potato and rose for one day in Petri dishes (21×2.5cm diameter) (Figure 2). Subsequently, these treated larvae were fed with respective untreated fresh leaves of host plants at every 24 hrs.

Observations were made on larval mortality at 24 h intervals from second to tenth day to establish LC_{50} and LT_{50} values.

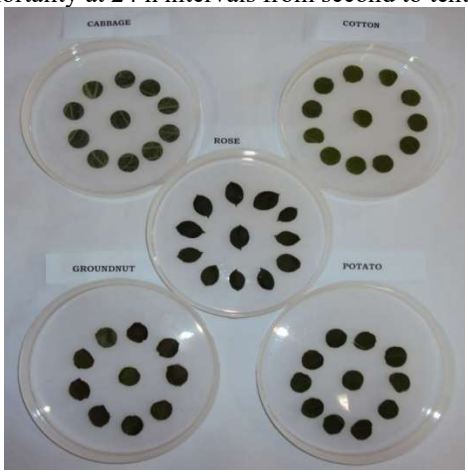

Figure 2 Leaf discs of different host plants

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3.3 Interaction between host plants and SlNPV

In the third experiment, to understand the direct effect of host plants on SlNPV as well as through S. litura larvae, which were reared on the different host plants even after the treatment, newly emerged S. litura adults on semi-synthetic diet were paired and caged for egg laying. Newly hatched S. litura larvae were reared on cabbage, cotton, groundnut, potato, and rose plants in the green house and allowed to complete their generation. Newly emerged the female and male moths of S. litura from these cultures 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 the Petri dishes for one day and later they were fed with untreated leaves till completion of their development or death.

In all the above experiments, to force the larvae to ingest the SlNPV treated food, they were kept starved for 2 hrs before the treatment as followed earlier (Trang & Chaudhari, 2002). In all the experiments, the larvae reared on semi synthetic diet were treated as control. For each treatment, there were five replications with ten larvae per replication. Bioassay of SlNPV using 1×10^6, 2×10^5, 4×10^4, 8×10^3, 1.6×10^3 and 3.2×10^2 concentrations were conducted.

Observations were made on larval mortality at 24 h intervals from second to tenth day to establish LC_{50} and LT_{50} values.

3.4 Chemical analysis of host plant foliage

Studies were carried out to know the interaction between biochemical factors of host plant foliage and SlNPV by quantifying the following biochemical factors using standard techniques.

3.4.1 Leaf surface pH

Fresh matured leaves of different host plants viz., groundnut, cabbage, cotton, potato and rose were collected randomly from the potted plants and brought into the laboratory. The leaves were dipped separately in beakers containing 100 ml of distilled water and stirred well for 10-15 minutes by holding the petioles as followed by Andrews and Sikorowski (1973). Then the pH of the treated water was recorded using a digital pH meter. Distilled water pH was considered as control.

3.4.2 Leaf extracts pH

About 300 mg of foliage of each host plant was taken for assessing the leaf extract pH. After removing the leaf midribs with help of a scissor, the sample was homogenized in 10 ml of chilled, deionized distilled water in a mini blender for 15 seconds at low speed as described by Appel and Maines (1995). The leaf homogenate was transferred to a 20 ml scintillation vial and pH was determined using a digital pH meter.

3.4.3 Larval midgut pH feed on different host plants

Fresh 25 neonate larvae of S. litura were transferred from semisynthetic diet to the respective host plants viz., groundnut, cabbage, cotton, potato and rose and reared up to late fifth instar stage. Then, fully fed ten larvae of uniform size were selected from different host plants and were immobilized on ice and dissected. First, without damaging the internal parts, larvae were cut opened all along the mid-dorsal line. Middle portion of gut was lifted using sterile forceps and gently pulled out by separating the trachea adhering to the midgut. The midgut part was cut off and immediately stored in ice cold 2 ml scintillation vial. Then the midgut was macerated by using sterilized glass rod and mixed well to release the inner contents. Then the midgut pH was recorded using a standard digital pH meter. The midgut pH of the sample was expressed as the average of pH of the ten larvae.

4. Results

Table 1. LT_{50} of SlNPV against Spodoptera litura reared on semi-synthetic diet and assayed on different host plants

Concentration (POBs/ml)	Host plants	LT_{50}	95% limit		Slope	Intercept	χ^{2**}
			Lower	Upper			
1×10^6	Groundnut	4.757	4.106	5.381	6.370	-4.315	16.338
	Cabbage	4.933	4.321	5.548	6.165	-4.273	10.065
	Potato	5.584	5.235	5.970	5.650	-4.220	8.707
	Cotton	6.135	5.743	6.612	5.553	-4.374	6.419
	Rose	6.312	5.873	6.877	5.050	-4.041	7.029
	Semi-synthetic diet*	4.323	3.876	4.833	9.132	-5.860	15.416
2×10^5	Groundnut	4.992	4.311	5.695	5.835	-4.075	15.898
	Cabbage	5.416	4.843	6.066	5.693	-4.177	10.689

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	Potato	6.106	5.683	6.631	4.990	-3.921	8.501
	Cotton	6.594	6.135	7.211	5.232	-4.286	5.538
	Rose	6.822	6.297	7.576	4.780	-3.986	5.941
	Semi-synthetic diet*	4.652	4.049	5.214	6.885	-4.597	15.596
4×10^4	Groundnut	5.707	5.046	6.562	5.149	-3.895	11.672
	Cabbage	6.046	5.631	6.554	5.029	-3.930	9.221
	Potato	7.010	6.449	7.843	4.740	-4.008	5.612
	Cotton	7.315	6.705	8.273	4.774	-4.126	4.880
	Rose	7.954	7.163	9.356	4.421	-3.982	3.681
	Semi-synthetic diet*	5.162	4.480	5.911	5.558	-3.962	14.959
8×10^3	Groundnut	6.063	5.654	6.564	5.135	-4.019	9.416
	Cabbage	6.612	6.101	7.323	4.612	-3.784	8.119
	Potato	7.769	7.020	9.056	4.402	-3.919	4.864
	Cotton	8.072	7.273	9.512	4.586	-4.159	3.486
	Rose	8.607	7.699	10.413	4.899	-4.580	2.078
	Semi-synthetic diet*	5.564	4.951	6.304	5.425	-4.044	11.148
1.6×10^3	Groundnut	6.492	6.019	7.126	4.881	-3.965	8.046
	Cabbage	7.130	6.534	8.040	4.595	-3.920	5.408
	Potato	8.350	7.461	10.033	4.460	-4.111	2.906
	Cotton	8.688	7.728	10.621	4.661	-4.376	2.429
	Rose	9.193	8.103	11.629	4.961	-4.779	2.215
	Semi-synthetic diet*	5.958	5.596	6.378	5.871	-4.551	6.657
3.2×10^2	Groundnut	7.156	6.548	8.092	4.520	-3.863	6.614
	Cabbage	7.954	7.163	9.356	4.421	-3.982	3.681
	Potato	9.164	8.023	11.655	4.440	-4.272	1.896
	Cotton	9.394	8.202	12.149	4.688	-4.560	2.321
	Rose	9.816	8.497	13.228	5.018	-4.978	2.346
	Semi-synthetic diet*	6.533	6.084	7.129	5.253	-4.282	6.527

*Control, **Non-significant, table χ^2 ($P<0.05$) at 6df = 12.592

4.1. Interaction between host plants and SlNPV

Spodoptera litura larvae were reared and assayed on different host plants, LC_{50} with respect to different host plants ranged from 0.32 to 1.68 POB/mm^2. The highest LC_{50} was recorded in rose (1.68) and the lowest in groundnut (0.32). However, the lowest LC_{50} was recorded in control of all the treatments (Table 5).

The ascending range of LT_{50} against S. litura larvae reared on different host plants and subsequently fed with SlNPV treated leaf discs of various host plants was as follows: groundnut 5.167-7.867, cabbage 5.442-8.273, potato 6.055-9.731, cotton 6.465-11.076 and rose 6.776-12.208. Again, the lowest LT_{50} was recorded in groundnut and the highest in rose as observed in the above two experiments. However, the lowest LT_{50} was recorded in control of all the treatments (Table 6).

Table 2. LC_{50} of SlNPV against Spodoptera litura reared & assayed on different host plants

Host plants	LC_{50} (POB/mm2)	Fiducial limits		Slope	Intercept	χ^{2**} (n-2)
		Lower	Upper			
Groundnut	0.32	0.12	0.76	0.54	0.26	0.30
Cabbage	0.46	0.17	1.13	0.51	0.17	0.28
Potato	0.72	0.28	1.84	0.51	0.07	0.26
Cotton	0.99	0.37	2.89	0.47	0.00	0.56
Rose	1.68	0.68	4.93	0.50	-0.11	0.30
Semi-synthetic diet*	0.07	0.02	0.17	0.57	0.64	1.98

*Control, ** All lines are significantly a good fit at $P<0.05$.

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Table 3. LT_{50} of SlNPV against Spodoptera litura reared and assayed on different host plants

Concentration (POBs/ml)	Host plants	LT_{50}	95% limit		Slope	Intercept	χ^{2**}
			Lower	Upper			
1×10^{6}	Groundnut	5.167	4.563	5.808	6.013	-4.289	13.012
	Cabbage	5.442	4.848	6.121	5.734	-4.219	11.481
	Potato	6.055	5.653	6.543	5.244	-4.102	9.020
	Cotton	6.465	5.994	7.096	4.851	-3.932	7.852
	Rose	6.776	6.246	7.534	4.662	-3.874	7.194
	Semi-synthetic diet*	4.323	3.876	4.833	9.132	-5.860	15.416
2×10^{5}	Groundnut	5.760	5.401	6.169	5.640	-4.289	7.682
	Cabbage	5.778	5.146	6.598	5.266	-4.012	10.828
	Potato	6.719	6.205	7.444	4.750	-3.930	6.737
	Cotton	7.047	6.469	7.919	4.612	-3.912	5.839
	Rose	7.400	6.734	8.474	4.422	-3.844	5.808
	Semi-synthetic diet*	4.652	4.049	5.214	6.885	-4.597	15.596
4×10^{4}	Groundnut	6.295	5.866	6.841	5.175	-4.135	6.363
	Cabbage	6.677	6.158	7.408	4.624	-3.813	7.680
	Potato	7.544	6.869	8.652	4.604	-4.040	4.454
	Cotton	7.837	7.055	9.203	4.268	-3.816	5.106
	Rose	9.073	7.872	11.643	3.845	-3.683	4.374
	Semi-synthetic diet*	5.162	4.480	5.911	5.558	-3.962	14.959
8×10^{3}	Groundnut	6.753	6.262	7.438	5.087	-4.219	4.430
	Cabbage	7.102	6.508	8.008	4.559	-3.882	5.823
	Potato	8.634	7.629	10.637	4.209	-3.941	3.677
	Cotton	9.304	8.021	12.150	3.830	-3.710	3.852
	Rose	9.954	8.463	13.655	4.024	-4.016	2.200
	Semi-synthetic diet*	5.564	4.951	6.304	5.425	-4.044	11.148
1.6×10^{3}	Groundnut	7.191	6.645	8.014	5.227	-4.478	3.229
	Cabbage	7.590	6.958	8.623	5.095	-4.485	3.916
	Potato	9.150	8.005	11.647	4.374	-4.206	2.463
	Cotton	9.964	8.457	13.704	3.945	-3.939	2.310
	Rose	11.064	9.116	17.153	4.223	-4.409	0.740
	Semi-synthetic diet*	5.958	5.596	6.378	5.871	-4.551	6.657
3.2×10^{2}	Groundnut	7.867	7.170	9.067	5.061	-4.533	2.668
	Cabbage	8.273	7.484	9.744	5.135	-4.172	2.358
	Potato	9.731	8.419	12.975	4.734	-4.678	1.238
	Cotton	11.076	9.103	17.166	4.064	-4.244	1.212
	Rose	12.208	9.675	23.474	4.510	-4.901	0.279
	Semi-synthetic diet*	6.533	6.084	7.129	5.253	-4.282	6.527

*Control, **Non-significant, table χ^2 ($P<0.05$) at 6df = 12.592.

5. DISCUSSION

5.1. Screening of SlNPV in the laboratory

The present study was conducted to understand the influence of host plants on the virulence of SlNPV both in the laboratory and field. Results of all the three experiments viz., a) without direct contact between host plants and SlNPV b) with direct contact between host plants and SlNPV and c) with direct contact between host plants and SlNPV as well as host plants influence through the host insect.

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The lowest pH in ground nut was due to Keating et al. (1988) reported a significant positive correlation between susceptibility to nuclear polyhedrosis virus and leaf tissue pH.

Difference in midgut pH among larvae fed on different host plant species reflected differences in the pH and buffering capacity of the foliage. The dissolution of PIBs was strongly affected by both the pH and the ionic strength of the solution. More alkaline the pH, more rapid will be the dissolution. The variation in the midgut pH on different host plants may be due to the pulsed movement of stored foliage from the foregut into the midgut causing a brief drop in midgut pH. Furthermore, it was reported that larvae consuming highly acidic and strongly buffered oak foliage have significantly lower midgut pH levels than do larvae consuming aspen foliage (Schultz and Lechowicz 1986). Dow (1984) and Schultz and Lechowicz (1986) have reported the larval midgut pH varies along the length of the midgut and also varies with the diet and time of feeding. Lower mortality rates were strongly associated with food material which lowered larval midgut pH levels. Stiles and Paschke (1980) concluded that decreasing midgut pH increased the susceptibility of mosquito species to a nuclear polyhedrosis virus. Midgut pH is through to have a strong influence on both PIB dissolution rates and virion survival (Ignoffo and Garcia 1966; Gudauskas and Canerday 1968). The actual route of entry of NPV infection in lepidopteran larvae is per os while the primary defence (s) against infection appears to be in the midgut (Stairs 1965; Watanabe 1966; David 1978; Granados and Williams 1987; Keddie et al. 1989).

Moreover, lepidopteran larvae, maintain high midgut pH levels (Berenbaum 1980). Midgut pH affect the digestive enzymes and larval ability to digest and absorb nutrients in the presence of digestion inhibitors (Dadd 1975; Berenbaum 1980). Midgut pH also affects the susceptibility of insects to pathogens (Heimpel 1955; Sharpe and Detroy 1979; Stiles and Paschke 1980). Foliage pH may influence GmNPV activity its impact on midgut pH. Schultz and Lechowicz (1986) observed that gypsy moth, Lymantria dispar larvae fed foliage from different host plant had significantly different midgut pH levels. Foliage pH influence NPV activity through its impact on midgut pH. Midgut pH is thought to have a strong influence on both polyhedral inclusion body (PIB) dissolution rates and virion survival (lgnoffo & Garcia; Gudauskas & Canerday 1968).

All food digestion and nutrient absorption occur in the midgut where the typical pH 9.0 and pH 10.0. The midgut and associated glands secrete the digestive enzymes needed to breakdown food. The larval midgut is completely without protection against pathogens. The larval midgut has peritrophic membrane which protects the midgut cells against abrasion (Wigglesworth 1972) and helps maintain the alkaline environment (Santos and Terra 1986). The membrane consists of chitin, glucosaminoglycans, glycoproteins and proteins (Barbehenn and Martin 1995). The glycosaminoglycan molecules are negatively charged in the midgut environment and have been shown to repel negatively charged particles such as viruses (Ashhurt 1985). The environment of the trachea is less basic than in the midgut and glycosaminoglycan molecules are not charged, making the cells more susceptible to infection. The trachea had always been considered secondary sites of infection in lepidoptera (Krywienczyk 1963). But the recent data have implicated trachea as the primary sites of infection (Engelhard et al. 1994).

Host plants have been reported to alter the susceptibility of insects to pathogen (Benz 1987). Specifically, the leaf material from wide range of host plants has been shown to inhibit the effect of NPV. Host plant foliage also affects pathogen through its effect on the pH of insect's digestive tract. It could be direct antagonism between leaf characteristics and microbes (Khaire and Khaire 1986, Kushner & Harvey 1962), altered effectiveness of infection barriers such as biochemical environment of the midgut lumen and peritrophic membrane (Paschke & Summers 1975) or physiological stress which may inhibit resistance at the cellular level (Steinhaus 1958).

6. SUMMARY AND CONCLUSION

Spodoptera litura Fabricius (Lepidoptera: Noctuidae), the tobacco caterpillar is a polyphagous pest attacking 65 plant species belonging to 22 families. S. litura has developed resistance to several organic pesticides resulting severe crop losses.

In the case of S. litura larvae reared on different host plants and subsequently fed with SlNPV treated semi-synthetic diet, the highest LC_{50} was recorded in rose and the lowest in groundnut. However, the lowest LC_{50} was recorded in control of all the treatments.

The range of LT_{50} at different concentrations on different host plants in the ascending order was as follows: groundnut, cabbage, potato, cotton and rose. The lowest LT_{50} was recorded in groundnut and the highest in rose within the same concentration. However, the lowest LT_{50} was recorded in control of all the treatments.

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Spodoptera litura larvae reared on semi-synthetic diet and assayed on different host plants, the highest LC_{50} was recorded in rose and the lowest in groundnut. However, the lowest LC_{50} was recorded in control.

The range of LT_{50} at different concentrations against S. litura larvae reared on semi-synthetic diet and subsequently fed with SlNPV treated leaf discs of various host plants in the ascending order was as follows: groundnut, cabbage, potato, cotton and rose. The lowest LT_{50} was recorded in groundnut and the highest in rose within the same concentration. However, the lowest LT_{50} was recorded in control of all the treatments.

Spodoptera litura larvae were reared and assayed on different host plants, the highest LC_{50} was recorded in rose and the lowest was in groundnut. However, the lowest LC_{50} was recorded in control of all the treatments.

The ascending range of LT_{50} against S. litura larvae reared on different host plants and subsequently fed with SlNPV treated leaf discs of various host plants was as follows: groundnut, cabbage, potato, cotton and rose. Again, the lowest LT_{50} value was recorded in groundnut and the highest in rose. However, the lowest LT_{50} was recorded in control of all the treatments.

The leaf surface pH was lowest in groundnut and the highest in rose. The highest leaf extract pH was recorded in rose and the lowest in groundnut. The highest midgut pH was recorded in S. litura larvae fed on rose leaves and the lowest on groundnut. The highest total phenol content was recorded in rose and the lowest in groundnut. The highest host plant total tannin content was recorded in rose and the lowest in groundnut. The highest amount of tyrosine was recorded in S. litura larvae fed on rose leaves and the lowest amount in the case of groundnut.

A field trial was conducted to test the bioefficacy of SlNPV against early instars of S. litura on groundnut, cabbage, potato, cotton and rose. The viral suspensions were evaluated at five doses., $2.5x10^{11}$, $5x10^{11}$, $7.5x10^{11}$, $1x10^{12}$, $1.5x10^{12}$ POBs/ac in comparison with different insecticides commonly used in different cropping systems.

In the first spray, number S. litura larvae was significantly reduced on the groundnut plants treated with chloropyriphos compared to other doses of SlNPV on the fifth day after treatment. Similar trend was observed on the seventh day after treatment in the first spray. However, on the tenth day after treatment, the reduction in larval number with various doses of SlNPV was on par with chloropyriphos.

In the second spray, reduction in number of S. litura larvae on the groundnut plants treated with chloropyriphos was significantly different from other doses of SlNPV on the fifth day after treatment. Similar trend was observed on the seventh and the tenth day after treatment under same schedule of spray.

In the third spray, the reduction in number of S. litura larvae on the groundnut plants treated with chloropyriphos was significantly different from other doses of SlNPV on the fifth and the seventh day after treatment. However, the reduction in number of S. litura larvae on the tenth day after treatment with different doses of SlNPV was on par with chloropyriphos. In all the schedule of sprays, number of S. litura larvae was increased on the control plants and it was significantly different from other treatments. During the three-spray schedule, the leaf damage in all the treatments was on par with each other except control.

In the first spray, number S. litura larvae was significantly reduced on the cabbage plants treated with Endosulphon compared to other doses of SlNPV on the fifth day after treatment. However, on the seventh and tenth day after treatment, the reduction in larval number with various doses of SlNPV was on par with Endosulphon.

7. References

1. Abbott WS (1925) A method of computing the effectiveness of an insecticide. J Econ Entomol 18:265–267
2. Ahmad JN, Mushtaq R, Ahmad SJN, Maqsood S, Ahuja I, Bones AM (2018) Molecular identification and pathological characteristics of NPV isolated from Spodoptera litura (Fabricius) in Pakistan. Pak J Zool 50:2229–2237
3. Ahmad M, Mehmood R (2015) Monitoring of resistance to new chemistry insecticides in Spodoptera litura (Lepidoptera: Noctuidae) in Pakistan. J Econ Entomol 108(3):1279–1288
4. Ali H, Hou Y, Tang B, Shi Z, Muhammad A, Sanda NB (2016) A way of reproductive manipulation and biology of Wolbachia pipientis. J Exp Biol Agric Sci 4(2):156–168
5. Arif M, Islam SU, Adnan M, Anwar M, Ali H, Wu Z (2018) Recent progress on gene silencing/suppression by virus-derived small interfering RNAs in rice viruses especially Rice grassy stunt virus. Microb Pathog 125:210–218

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6. Arrizubieta M, Simón O, Torres-Vila LM, Figueiredo E, Mendiola J, Mexia A, Caballero P, Williams T (2016) Insecticidal efficacy and persistence of a co-occluded binary mixture of Helicoverpa armigera n0ucleopolyhedro virus (Hear NPV) variants in protected and field-grown tomato crops on the Iberian Peninsula. Pest Manag Sci 72(4):660–670
7. Arti P, Yogita W (2014) Field compatibility of microbial pesticide SL NPV with synthetic pesticide Roket, Cypermethrin + Profenofos] against tobacco caterpillar Spodoptera litura [Fabricus]. Res J Pharm Biol Chem Sci (2) 4:767
8. Aydin MH, Gurkan MO (2006) The efficacy of Spinosad on different strains of Spodoptera littoralis (Boisduval) (Lepidoptera: Noctuidae). Turkish J Biol 30:5–9
9. Ayyub MB, Nawaz A, Arif MJ, Amrao L (2019) Individual and combined impact of nuclear polyhedrosis virus and spinosad to control the tropical armyworm, Spodoptera litura (Fabricius) (Lepidoptera: Noctuidae), in cotton in Pakistan. Egypt J Biol Pest Control 29(67):1–6
10. Bala NS, Muhammad A, Ali H, Hou Y (2018) Entomopathogenic nematode Steinernema carpocapsae surpasses the cellular immune responses of the hispid beetle, Octodonta nipae (Coleoptera: Chrysomelidae). Microb Pathog 124:337–345
11. Cory JS, Myers JH (2003) The ecology and evolution of insect baculoviruses. Annu Rev Ecol Evol Syst 34:239–272
12. El-Helaly AA, El-bendary HM (2013) Impact of Spinosad and Nucleopolyhedrosis virus alone and in combination against the cotton leaf worm Spodoptera littoralis under laboratory. App Sci Rep 2(1):17–21
13. Gao C, Bei Y, Chen T, Gu X (2004) On factors causing outbreak of Spodoptera litura (Fabricius). Acta Agri Zhejiangensis 16:332–335
14. Hu Z, Chen X, Sun X (2003) Molecular Biology of Insect Viruses. A review. Adv Microb Control Insect Pests:83–107
15. Jansson RK, Peterson RF, Mookerjee PK, Halliday WR, Argentine JA, Dybas RA (1997) Development of a novel soluble granule formulation of emamectin benzoate for control of Lepidopterous pests. Flo Entomol 80:425–442
16. Ma X, Liu X, Ning X, Zhang B, Han F, Guan X, Tan Y, Zhang Q (2008) Effects of Bacillus thuringiensis toxin Cry1Ac and Beauveria bassiana on Asiatic corn borer (Lepidoptera: Crambidae). J Invert Pathol 99:123–128
17. Maqsood S, Afzal M, Haider MS, Khan HAA, Ali M, Ashfaq M, Aqueel MA, Ullah MI (2019) Effectiveness of uuclear polyhedrosis virus and Bacillus thuringiensis alone and in combination against Spodoptera litura (Fabricius). Pak J Zool 51(2):631–641