PERSISTENCE OF A NUCLEOPOLYHEDROVIRUS ON PLANT SURFACES

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Abstract

A critical factor in the effectiveness of insect viruses as microbial control agents is their short persistence on leaf surfaces. The reduction of infective virus on a leaf surface is largely due to virus inactivation. The purpose of this study was to assess the effect of host plant on the persistence of the *Helicoverpa zea* single-nucleocapsid nucleopolyhedrovirus (SNPV). Small field tests were conducted on six host plants. Virus was applied at application rates of 1.2 X 10^{11}, 2.4 X 10^{11}, and 8.1 X 10^{11} occlusion bodies (OB's) /acre with each of the virus treatments and the untreated control replicated four times. Virus activity was measured using six d old *H. virescens* larvae at 0, 1, 3, 5, and 7 d post application. All virus treatments were equally effective at the 0 d sampling date. Virus persistence varied depending on the host plant. Virus inactivation was rapid on cotton, whereas inactivation of *H. zea* SNPV on the remaining host plants was not as rapid.

Introduction

The cotton bollworm, *Helicoverpa zea* and the tobacco budworm, *Heliothis virescens* infested 79% of the U.S. cotton acreage in 1997 (Herzog et. al., 1998). These two heliothine species were ranked the second most damaging pest species on upland cotton, *Gossypium hirsutum* L. and were responsible for a 2.01% reduction in yield or ca. 536,618 bales (Williams, 1998).

The *Helicoverpa zea* single-nucleocapsid nucleopolyhedrovirus (SNPV) is the only commercially available insect virus for cotton bollworm and tobacco budworm control in the United States. Persistence of *H. zea* SNPV has been investigated on cotton (Bullock, 1968; Young and Yearian, 1974; Yearian and Young, 1974; Potter and Watson, 1984), and several other cultivated crops(Young and Yearian, 1974). Studies on the persistence of *H. zea* SNPV on foliage of wild host plants have been limited to a few reports on wild geranium, crimson clover, and velvetleaf (Bell and Hayes, 1994; Ali et. al., 1998).

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Persistence of insect viruses on the host plant is a very important issue in the development of viruses as microbial control agents. The short persistence of insect viruses on host plants is primarily due to an inactivation of virus particles. Therefore studies have been conducted to determine the factors that inactivate insect viruses on plant surfaces, especially physical environmental factors. In recent years the influence of the host plants on insect viruses has received greater attention (Ali et. al., 1998; Hoover et. al., 1998a; 1998b).

This study examined *H. zea* SNPV persistence on foliage from six host plants. In the Mississippi Delta, four of these plant species are wild hosts used by the cotton bollworm and tobacco budworm as a food source during the first generation before the availability of cultivated crops such as cotton (Stadelbacher, 1981). One of our main objectives for conducting this study was to demonstrate the applicability of managing cotton bollworm and tobacco budworm populations on wild host plants with the *H. zea* SNPV.

Materials and Methods

Small field tests were conducted to assess the persistence of *H. zea* SNPV on the host plants, white clover, Trifolium repens; crimson clover, Trifolium incarnatum; velvetleaf, Abutilon theophrasti; soybean, Glycine max;; geranium, *Geranium dissectum*; and cotton (Deltapine 5409), *G. hirsutum*. The H. zea SNPV (Gemstar™ LC Thermo Trilogy, Inc.) was applied at application rates of 1.2 X 10^{11}, 2.4 X 10^{11}, and 8.1 X 10^{11} occlusion bodies (OB's) /acre. Each of the virus formulations and the untreated control were replicated four times. Plots were 36 sq. ft. for the crimson clover, geranium, and white clover studies, whereas the velvetleaf, soybean, and cotton studies were conducted on 4 row ft. plots. The treatments were randomized for each replicate. Plant terminals were removed randomly from both the control and the virus-treated plots at 0,1,3, 5, and 7 d post-application. Thirty-two *H. virescens* larvae (6 d old) were individually fed a single plant terminal for 48 hrs from each plot on a given sampling date. Those that failed to consume the entire plant terminal were excluded from the assay. The remaining larvae were placed on clean artificial diet and reared for 14 d at 30 degrees C. Virus inactivation was measured by recording viral mortality 14 d after the initial feeding period. Original activity remaining (OAR) was calculated by dividing percent mortality of sample at a given time period by the percent mortality at 0 h and multiplying by 100.

Results and Discussion

All virus treatments were equally effective at 0 d post-application. The percentage of original virus activity remaining on plant foliage after 1 d post-application was positively related to the application rate of virus. These results corroborate an earlier report by Potter and Watson

(1984) on the relationship between virus application rate and viral persistence.

Viral persistence reported in this paper should not be considered representative of the effectiveness of commercial formulations. No attempt was made to increase virus persistence through formulation because we were interested in observing the effect of various factors on virus inactivation.

Virus activity on foliage was significantly reduced on all six host plants at 1 d post application. Virus inactivation was greatest in cotton foliage with <44% OAR observed at 1 d post application at the highest virus application rate. Inactivation of *H. zea* SNPV on wild host plants and soybean was not as rapid at 1 d with >53% OAR observed at the highest virus application rate.

The original virus activity present on cotton foliage was < 6% at 3 d post-application at the highest virus application rate. While all of the wild host plants and soybean, showed >20% of the original virus activity at 3 d post-application for the highest virus application rate.

The original virus activity present on cotton foliage was only 2% at 5 d post-application for the highest virus application rate. Inactivation of *H. zea* SNPV on wild host plants was not as rapid with some original virus activity remaining after 5 to 7 d post-application. All of the wild host plants except geranium showed >24% of the original virus activity at 5 d post-application for the highest virus application rate. The original virus activity remaining on geranium was much lower at 6%, whereas soybean had a higher original virus activity of 17%.

Original virus activity was absent on cotton foliage at 7 d post-application for all virus application rates. At the highest virus application rate more than 20% of the original virus activity remained on crimson clover and velvetleaf foliage at 7 d post-application. Some original virus activity remained on geranium, white clover, and soybean foliage at the higher virus application rate at 7 d post-application.

Conclusion

H. zea SNPV was more persistent on wild host plant foliage than on cotton foliage. These results strongly suggest that host plants may be responsible for virus inactivation to a greater extent than previously assumed in earlier studies. An area-wide program with *H. zea* SNPV to manage cotton bollworm and tobacco budworm populations during the first generation on wild host plants should be more effective because the virus persists longer on wild host plants.

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Table 1. Persistence of *Helicoverpa zea* SNPV (Gemstar) determined by Bioassay of Virus-Treated Plant Terminals with neonate Tobacco budworms.

Plant	Treatment[1] Rate (OB's/A)	Days Post Application (OAR % Mortality[2])				
		0	1	3	5	7
Cotton						
	1.2x10"	100	2	0	0	0
	2.4x10"	100	22	4	2	0
	8.1x10"	100	44	6	2	0
Geranium						
	1.2x10"	100	44	7	0	0
	2.4x10"	100	61	12	4	3
	8.1x10"	100	71	21	6	3
White Clover						
	1.2x10"	100	53	21	11	0
	2.4x10"	100	57	27	16	0
	8.1X10"	100	87	31	24	8
Crimson Clover						
	1.2x10"	100	41	14	5	2
	2.4x10"	100	50	28	15	7
	8.1x10"	100	59	30	26	20
Velvetleaf						
	1.2x10"	100	19	12	5	2
	2.4x10"	100	39	34	24	11
	8.1x10"	100	53	44	34	21
Soybean						
	1.2x10"	100	74	23	9	0
	2.4x10"	100	79	31	14	2
	8.1x10"	100	79	44	17	6

[1] Gemstar® is a product of Thermo Trilogy, Inc.
[2] OAR= Original activity remaining.