EFFICACY OF GENETICALLY MODIFIED AND CONVENTIONAL BACULOVIRUSES FOR CONTROL OF BOLLWORM (*HELICOVERPA ZEA*) (BODDIE) IN B.T. AND CONVENTIONAL NON-B.T. COTTON (*GOSSYPIUM HIRSUTUM*) (L.)

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Abstract

Both genetically-modified (GM) and non-modified baculoviruses were tested alone and with an ovicide for control of cotton bollworm, *Helicoverpa zea* (Boddie), in Bt and conventional cotton. GM viruses, engineered for faster kill (Dupont), were compared to a conventional virus (Dupont) and to Asana™ in Bt and conventional cotton in 1998. In 1999, bollworm populations were very low and did not reach treatment thresholds in Bt cotton. Therefore, the viruses were compared with a Karate™ standard only in conventional cotton. In 1998 in conventional cotton, bollworm populations were significantly lower in all treatments compared to untreated checks, however only the Asana™ standard gave adequate control. In 1998 in Bt cotton the GM virus IC917-11 with IC848-14 (Dupont) and the pyrethroid Asana™ both provided significantly better control than the untreated checks. In 1999, on conventional cotton, all virus treatments were significantly better than check plots and combinations with an ovicide substantially improved the efficacy of the viruses.

Introduction

In South Carolina, control of the cotton bollworm, *Helicoverpa zea* (Boddie), usually requires multiple applications of pyrethroid insecticides on conventional cotton, and one to four supplemental applications on Bt cotton (Brickle et al. 1999). Because baculoviruses replicate and persist in the environment, they may help maintain pest populations below damaging levels with fewer applications than chemical controls (Moscardi 1999). Baculoviruses have high specificity, are environmentally safe and may be an avenue in dealing with resistance problems (Marrone 1996). Naturally-occuring baculoviruses: 1. have a slow rate of kill, 2. are difficult to prepare and apply, and 3. are inactivated by UV light (Marrone 1996, Street et al. 1999). Several studies have evaluated *H. zea* nuclear polyhedrosis viruses (HZNPV) as insecticides for control of the budworm/bollworm complex in cotton: (Bell and Hayes 1994, Street et al. 1997, and Heinz et al. 1999) and results varied, but at least forty percent control was obtained under differing application scenarios. Viral insecticides have shown promise against *H. zea* but they have not been as effective as conventional insecticides (i.e. pyrethroids). Dupont has genetically-modified HZNPVs for faster kill. In this study, we compared viruses genetically-modified for faster kill (Dupont), non-modified viruses (both from Dupont, and Gemstar™ from Thermo-Trilogy), and pyrethroids for bollworm control in cotton. Viruses were applied alone and in combination with an ovicide.

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Materials and Methods

1998

In 1998, two fields, one in Estill, SC and one at the Edisto Research and Educational Center (EREC) were planted half with the conventional 'DP 5415' variety and half with the Bt 'NuCotn 33b' variety cotton. Both fields were planted in early June and treated early in the season with acephate. The fields were divided into plots 12 rows wide by 50 feet long in a randomized block design with four replications. The Estill field was treated on 07/07, 07/10, and 07/17 around noon on each date. Three samples per plot were taken on 07/24 to determine bollworm numbers in conventional cotton at the Estill field. The Estill field was subsequently abandoned due to drought and results were not used. The EREC field was treated 07/10, 07/13, 07/22, and 07/29. All treatments were applied either in the morning before 11:00am or in the late afternoon around 5:30pm. In the EREC field, a 1 meter by 1 meter beat cloth (Shepard et al. 1974) was used to take three samples of bollworm populations per plot on 07/20 and 07/28 in conventional cotton and four samples per plot on 07/31 in Bt cotton. Our sampling dates were not such that they would determine any quicker kill by the GM Dupont viruses. Treatments consisted of: 1) Dupont IC917-11 (42 g/acre), 2) Dupont IC917-11 (34 g/acre) with Dupont IC848-14 (11 g/acre), 3) Dupont IC694-23 (71 g/acre) with Dupont IC687-47 (9 g/acre), 4) Dupont IC783-51 (200 g/acre), 5) Dupont ICI841-6 conventional virus (86 g/acre), 6) Asana™ as a pyrethroid check (.035 lb ai/ acre), and 7) an untreated check.

1999

In 1999, a field at EREC was planted during the last week of May half with the conventional variety, 'DP 5415' and half with the Bt variety, 'NuCotn 33b'. The field was divided into plots in a randomized block design. The plots were 12 rows wide by 30 feet long. There were four replications of each treatment and two untreated checks with four replicates each. The plots were treated on 07/22 at midday and 07/26 in late afternoon. Samples of bollworm larvae were taken with a 1m by 1m beat cloth, two per plot on 07/29 and eight samples on 08/08. A second field at EREC was planted with conventional 'DP 5415' during the first week of June. Plots 8 rows wide by 30 feet long were assigned in a randomized block design with four replications of each treatment except that Gemstar™ alone had only three replications. The plots were treated on

08/10 and 08/13 in the late afternoon. Samples of bollworm numbers were taken three per plot on 08/16 and four per plot on 08/20. Treatments consisted of: 1) Dupont IC917-103 (14.2g/acre) with IE773-9 (14.7 g/acre), 2) Dupont IC917-103 (14.2g/acre) with IE773-9 (14.7 g/acre) plus Larvin™ (0.2 oz/acre), 3) Dupont IC841-5 conventional virus (17.6 g/acre), 4) Thermo-Trilogy Gemstar™ (10 oz/acre) 5) Thermo-Trilogy Gemstar™(10 oz/acre) plus Larvin™ (0.2 oz/acre), 6) Karate™ as a pyrethroid check (0.025 lb ai/acre), and 7) an untreated check.

Weed control, fertilization and other agronomic practices were made according to South Carolina extension recommendations. Treatments were applied using CO_2 backpack sprayers with 4X hollow cone nozzles at 60psi that delivered 9.5 gal/acre. Insecticide and virus treatments were made using the South Carolina extension recommendations for an egg threshold of 15eggs/ 100 plants for conventional cotton. The 1998 season was exceptionally dry and the 1999 season was characterized by a rainy June followed by sustained drought.

Results and Discussion

In 1998 in conventional cotton, although bollworm populations were significantly lower in all treatments compared to untreated checks (Table 1), viral treatments did not provide adequate control. In Bt cotton, only genetically modified IC917-11 with IC848-14 (Dupont) and the pyrethroid Asana™ had significantly lower numbers of bollworm larvae than the untreated checks (Table 1).

In 1999 in conventional cotton only, bollworm populations were significantly lower in all treatments compared to untreated checks (Table 2). Virus plus ovicide treatments provided control similar to Karate ™ treatments. Virus only treatments, although significantly different from the untreated check, again did not provide adequate control.

In general, natural and genetically-modified viruses alone do not provide adequate control of the cotton bollworm, however IC917-11/ IC848-14 (Dupont) may have some potential for use in Bt cotton. Combinations of viruses plus ovicides (Larvin ™) show promise for use in conventional and Bt cotton. Further studies should be conducted that compare ovicides alone and viruses plus ovicides, particularly in Bt cotton.

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Table 1. Efficacy of GM HZNPV on Bollworm Populations in Conventional and Bt Cotton,1998.

		Mean larvae per meter	
Treatment	**Rate/ acre**	**conventional**	**Bt**
1) IC917-11	42 g	15.23b	4.17ab
2) IC917-11 and IC848-14	34g and 11g	15.53b	2.87b
3) IC694-23 and IC687-47	71g and 9g	13.53b	5.13ab
4) ICI783-51	200g	13.43b	4.63ab
5) ICI841-6	86g	11.50b	4.33ab
6) Asana	0.035 lb ai	4.83b	1.43b
7) Untreated	0	35.03a	7.67a

Means within columns followed by the same letter are not significantly different (Fisher's LSD, p=.05) Means from the Blackville field only.

Table 2. Efficacy of GM and Natural HZNPV on Bollworm Populations in Conventional Cotton 1999.

Treatment	Rate/ acre	Mean larvae per meter
1) IC917-103 and IE773-9	14.2g and 14.7g	3.11bc
2) IC917-103, IE773-9 and Larvin	14.2g, 14.7g and 8oz	0.86c
3) IC841-5	17.6 g	3.13bc
4)Gemstar	10 oz	4.11b
5)Gemstar and Larvin	10oz and 8oz	0.72c
6) Karate	0.0025 lbs a.i.	0.96c
7) Untreated	0	7.78a

Means within columns followed by the same letter are not significantly different (Fisher's LSD, p=.05). Means from two fields