Title: Biological control of black cutworm in turf with baculovirus - 2016

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Objectives:

1) Determine effective application rates and formulations of the virus required for control of larvae,
2) Compare baculovirus treatments with alternative control treatments when applied under field conditions,
3) Evaluate compatibility of virus applications with integrated management strategies for pest control within the golf-turf environment.

Start Date: Spring 2015

Project Duration: 3

Total Funding: $60,000

Bullet Points

Young black cutworm larvae remain susceptible to infection by baculovirus for five days after hatching (prior to reaching the fourth instar of development), suggesting that recurring weekly applications may provide effective control of this pest. (Figure 2)

Applications of baculovirus occlusion bodies (OBs) to field grown bentgrass degrade rapidly, especially when applied at low rates (<1.6 x 10^{11} OBs/A), thus limiting pest control efficacy. (Figure 3)

Weekly treatments of field grown bentgrass managed at putting green height provided consistent control of small and medium sized larvae when the baculovirus was applied at high "label" recommended rates (1.6 x 10^{11} OBs/A), but did not provide improved efficacy after three weekly applications. (Table 1)

After artificial infestations of small and medium sized larvae, virus treatments at the higher rates significantly reduced feeding damage to bentgrass, although the slow speed of kill allowed some damage to occur.

Summary text:

Research continues to hone in on the requirements needed to develop the baculovirus, *Agip*MNPV, as a biological insecticide for control of black cutworm (BCW) larvae in turf. This year, field and laboratory experiments evaluated application rates, multiple applications, caterpillar susceptibility, and residual insecticidal activity. The unifying premise of the experiments was to determine if multiple applications of virus would be capable of providing season long control of cutworm larvae infesting managed turfgrass.

Larval susceptibility to virus infection

For most insects, susceptibility to infection by pathogens decreases as development proceeds through the larval stages (instars). In the laboratory, larvae completed three instars in 5 days and remained highly susceptible to virus infection. Beginning at 6 days, larvae entered the fourth instar and required significantly more virus to initiate infection (Figure 1). The high susceptibility of small larvae suggests that applications at 5-day intervals could effectively control larvae hatching from a continuous infestation.

Evaluations for residual insecticidal activity

Treatment intervals could be extended if the virus remains active for an extended time period after application. Unfortunately, insecticidal activity decreased rapidly for low and medium application rates ($\geq 1.6 \times 10^6$ OBs/A) to field grown bentgrass, which lost about 50 % of the original activity by two days after application (Figure 2). The high application rate (1.12×10^{12} OBs/A) maintained insecticidal activity with over 90% larval mortality for two days after application.

Virus source – commercial samples vs laboratory samples

Andermatt Biocontrol (Grossdietwil, Switzerland) is in the process of developing an *Agip*MNPV biopesticide for control of black cutworm and provided a test sample of product (Exilon) for evaluation. In preliminary laboratory experiments, the commercial sample provided equivalent insecticidal activity with freshly produced virus (NCAUR). This was the first indication to support the application of either commercial or laboratory produced samples in the following experiments.

Field efficacy experiments – Purdue University

Three weekly application of virus treatments were sprayed on field plots of creeping bentgrass that was maintained at 3/16 inch height and managed as a golf green to determine if repeated applications would build up residue of virus and improve control of cutworms. All treatments (low and medium rates; Exilon and NCAUR virus sources) were applied as aqueous sprays at 2 gallons/1000 ft^2. After applications dried, PVC cages (8 inch diameter) were installed in plots and artificially infested with neonates or five 2^{nd}- 3^{rd} instar BCW larvae. Larvae were allowed to feed within the cages for seven days before being flushed from the turf using a standard soapy water solution. Larval survival in treated plots was compared with larval survival in untreated control plots and plots treated with a chemical standard, Acelepryn SC (chlorantraniliprole). Larvae counts and plant damage estimates are reported in Tables 1 and 2, respectively.

Exilon and NCAUR sources of virus provided similar levels of control and medium application rates provided better control than lower application rates. None of the virus treatments matched the level of control provided by the chemical insecticide. Lower levels of control by virus applications were expected because medium and low rates of virus were applied in an effort to observe improvements in pest control due to repeated applications to the same plots. Unfortunately this benefit was not observed.

Table 1. Mean (±SE) number and percent control of black cutworm neonates and 2nd and 3rd instar larvae in plots of creeping bentgrass treated with different formulations (NCAUR and Exilon) and rates of baculovirus (*Agip*MNPV) or Acelepryn SC (chlorantraniliprole). Two hundred eggs and five 2nd and 3rd instar larvae were placed on plots at 8d intervals with treatments being applied at the beginning of each interval. The number of surviving larvae was recorded 7d after each application. Three applications were made and infestations were created on August 2, August 10, and August 18, 2016. Black cutworm larval populations were assessed on August 9, August 17, and August 25. 2016.

Treatment	Rate (ml or g/A)	Survival Interval 1	% Control Interval 1	Survival Interval 2	% Control Interval 2	Survival Interval 3	% Control Interval 3
				Neonates			
Untreated		130.5± 9.7ab	0.0	197.5± 1.7a	0.0	147.8±32.8a	0.0
Exilon	320.0 ml	81.0±16.4b	37.9	148.3±11.2b	24.9	48.3± 8.3cd	67.3
Exilon	44.0 ml	103.5±17.3ab	20.7	193.0±14.3a	2.3	88.8±17.4b	39.9
NCAUR	72.7 g	72.6± 8.9b	44.4	104.8± 8.2c	46.9	27.0±11.0de	81.7
NCAUR	10.0 g	94.5± 5.0ab	27.6	144.8±12.5b	26.7	76.5± 4.9bc	48.2
Acelepryn	354.0 ml	0.0± 0.0c	100.0	0.0± 0.0d	100.0	0.0± 0.0e	100.0
				2nd & 3rd Instar			
Untreated		4.5±0.3ab	0.0	4.0±1.3a	0.0	2.8±0.6ab	0.0
Exilon	320.0 ml	1.3±0.8cd	71.1	1.3±0.bc	67.5	2.3±0.9ab	17.9
Exilon	44.0 ml	4.8±0.5a	0.0	2.8±0.8ab	30.0	3.8±0.5a	0.0
NCAUR	72.7 g	2.0±0.9c	55.6	0.5±0.5c	87.5	1.3±1.3bc	53.6
NCAUR	10.0 g	4.0±0.4ab	11.1	1.0±0.7c	75.0	2.5±0.9a	10.7
Acelepryn	354.0 ml	0.0±0.0d	100.0	0.0±0.0c	100.0	0.0±0.0c	100.0

*Numbers in same column followed by different letters are significantly different at α=0.05

Table 2. Mean (±SE) percent defoliation by black cutworm neonates and 2nd and 3rd instar larvae in plots of creeping bentgrass treated with different formulations (NCAUR and Exilon) and rates of baculovirus (*Agip*MNPV) or Acelepryn SC (chlorantraniliprole). Two hundred eggs and five 2nd and 3rd instar larvae were placed on plots at 8d intervals with treatments being applied at the beginning of each interval. Three applications were made and infestations were created on August 2, August 10, and August 18, 2016. Defoliation by black cutworm larvae was assessed on August 9, August 17, and August 25. 2016.

Treatment	Rate (ml or g/A)	% Defoliation Interval 1	% Defoliation Interval 2	% Defoliation Interval 3
Neonates				
Untreated		23.8±4.7b	57.5±11.1ab	27.5±4.3a
Exilon	320.0 ml	17.5±4.3bc	30.0± 7.1b	16.3±3.1ab
Exilon	44.0 ml	32.5±8.5a	73.8±14.6a	32.5±8.3a
NCAUR	72.7 g	22.5±4.3b	46.3±12.8ab	21.3±4.3ab
NCAUR	10.0 g	25.0±3.5b	46.3±14.0ab	22.5±1.4a
Acelepryn	354.0 ml	0.0±0.0c	3.8± 1.3c	0.0±0.0b
2nd & 3rd Instar				
Untreated		46.3±7.5a	40.0±17.3a	51.3±5.5a
Exilon	320.0 ml	21.3±4.7b	11.3± 3.8b	23.8±3.8c
Exilon	44.0 ml	48.8±5.2a	17.5± 1.4b	51.3±5.2a
NCAUR	72.7 g	32.5±7.5ab	12.5± 6.0b	30.0±4.6bc
NCAUR	10.0 g	42.5±7.5a	15.0± 8.4b	42.5±4.8ab
Acelepryn	354.0 ml	0.0±0.0c	2.5± 1.4b	0.0±0.0d

*Numbers in same column followed by different letters are significantly different at α=0.05

Figure 1. Plots of creeping bentgrass with pvc cylinders used to create artificial infestations of black cutworm neonates and 2nd & 3rd instar larvae for the experiment.

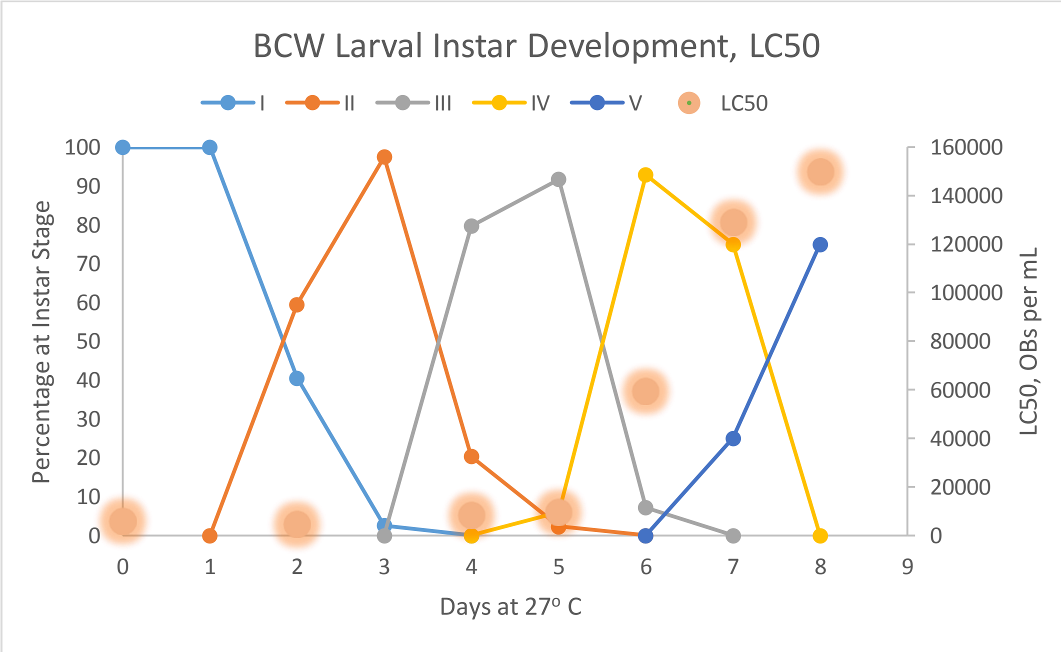

Figure 2. Development for black cutworm larvae and their susceptibility to infection by baculovirus (LC50) showing high susceptibility (low LC50 values) to virus through 5 days of growth (instars I, II, and III).

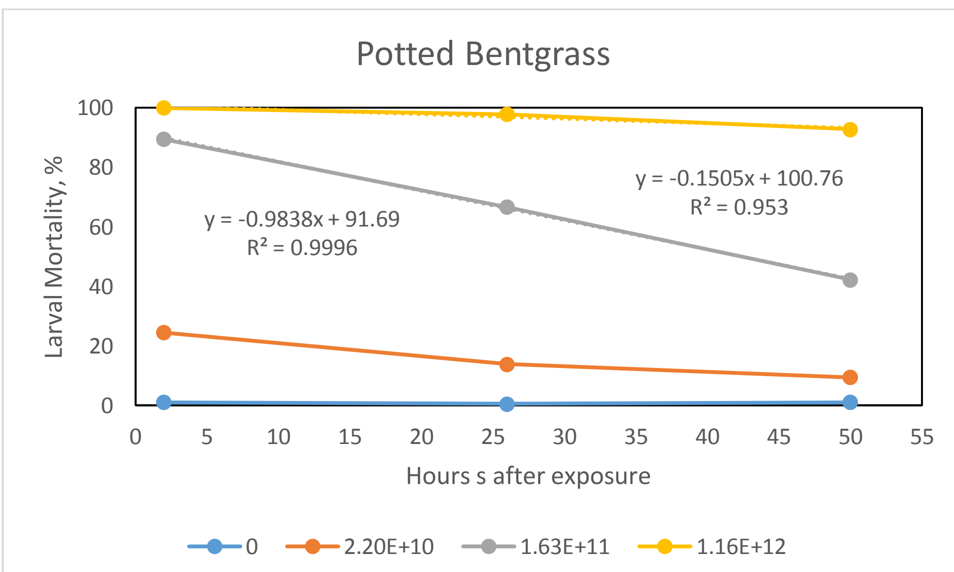

Figure 3. Loss of insecticidal activity based on larval mortality for four rates of *Agip*MNPV (0, 2.20×10^{10}, 1.63×10^{11}, 1.16×10^{12} OBs/A) applied to bentgrass after exposure to 2, 26, or 50 hours of natural weather conditions, measured as decreasing mortality of neonate black cutworm when exposed to treated bentgrass growing in pots.