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Title: Biological control of black cutworm in turf with baculovirus - 2017

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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

- Treating turf with the black cutworm baculovirus is a highly effective control treatment for black cutworm larvae.
- Alternative microbial-based biological treatments (a Beauveria fungus or a Bacillus bacterium) were less effective for control of cutworm larvae.
- Mixing biological agents for application to turf did not provide synergistic pest control, which has been observed for other insect pests.

Summary text:

The black cutworm (BCW) is a pest of bentgrass turf planted for golf courses. Larvae feed on the plants and create divots in greens that affect game play. Biological control technologies are sought to provide effective pest control and reduce hazards associated with conventional chemical pesticides. Although not yet registered as a commercial product in the U.S., the insect specific virus known as AgipMNPV is one agent with high potential to serve as a biological insecticide.

Our research focused on documenting pest control efficacy of virus treatments with and without other microbial-based pest control agents in an effort to support biological control of BCW larvae in turf. This year, experiments evaluated treatments consisting of individual and combinations of known microbial agents for efficacy against BCW larvae. The unifying premise of these experiments was to determine if multiple agents would provide greater than expected mortality (synergistic effects) for control of cutworm larvae infesting managed turfgrass. A synergistic combination would provide effective pest control with lower application rates of the biological pesticides, effectively reducing treatment costs. Synergy between microbial agents has been documented for other insect pests that are closely related to the BCW.

Preliminary experiments were conducted at the USDA-ARS laboratory in Peoria, IL to identify appropriate application rates to determine a synergistic interaction among three insect pathogenic microbes. The three microbial agents were: 1) baculovirus = AgipMNPV, 2) fungus = *Beauveria bassiana* strain GHA, and 3) bacterium = *Bacillus thuringiensis kurstaki*. The fungus and bacterium are the active agents in BotaniGard (Bioworks, Inc., Victor, NY) and Deliver (Certis USA L.L.C., Columbia, MD) insecticides, respectively. Application rates targeting 30-40% mortality of exposed insects were determined for each microbe. This relatively low activity level was necessary to provide the opportunity to observe higher than expect mortalities for combined treatments. Selected application rates were as follows: virus = 1×10^{11} occlusion bodies (virus particles) per acre, fungus = 5×10^{12} spores per acre, bacteria = 908 g product (Deliver) per acre. Telstar (bifenthrin) was applied at the labeled rate of 227.8 ml per acre.

To evaluate the relative efficacy against newly hatched and later instar larvae, six biopesticide treatments (virus, fungus, bacteria, virus + fungus, virus + bacteria, fungus + bacteria) and a chemical standard (Talstar) were applied on field plots of creeping bentgrass maintained at 3/16 inch height and managed as a golf green. An untreated control was included. Treatments were replicated 4 times using a randomized complete block design. All treatments were applied as aqueous sprays at the rates listed above using a total spray volume of 2 gallons/1000 ft^2, and each treatment was replicated 4 times (Fig 1). Before application, two PVC cages (8 inch diameter) were installed in each plot and were artificially infested with either twenty neonates or ten 2^{nd}- 3^{rd} instar BCW larvae. Larvae were allowed to feed within the cages for 16 days after treatment before being flushed from the turf using a standard soapy water solution. Number of live larval, larval mass (mg/plot), and plant damage estimates (%) were recorded for each cage in a plot. BCW control percentage was calculated based on the number of larvae for each treatment relative to the number of larvae in the control treatment.

The biological treatments applied at low application rates provided significant pest control of newly hatched and 2^{nd}-3^{rd} instar BCW larvae when compared with the untreated control plots (Table 1). Only the fungus (*Beauveria bassiana*) alone plots and the combined virus (AgipMNPV) + bacterium (*Bacillus thuringiensis*) plots had significantly more 2^{nd}-3^{rd} instar larvae than the Telstar treated plots and were not significantly different from the untreated plots. Unfortunately, no synergistic effects were observed for applications of combinations of microbial agents, leaving the virus treatment as the best choice among these biopesticide treatments.

Plant damage ratings varied widely among plots and these highly variable data did not provide statistical differences among treatments. Generally, larger larvae, 2^{nd}-3^{rd} instar, in the untreated plot caused considerable feeding damage (Fig. 1, A), but minimal feeding damage was observed in treated plots (Fig.1, B). By contrast, newly hatched larvae did little damage to the grass in either treated or untreated plots, averaging about 10% feeding damage among all plots (Fig. 1, C and D).

In conclusion, the virus alone treatment provided good control of small and medium sized larvae, even when applied at this low rate. We did not observed a synergistic benefit by applying multiple microbial organisms, maintaining the more traditional single product application for pest control.

Table 1. Survival (n/10±SE), percent control, mean larval mass (±SE) and % plant damage by neonates and 2nd and 3rd instar black cutworm larvae in plots of creeping bentgrass treated with Talstar (bifenthrin) or virus (AgipMNPV) alone and in combination with other biological control agents. Plots were infested and products were applied on September 26, 2017. Cutworm survival, larval mass, and percent damage was determined on October 12, 2017.

Treatment	Survival ± SE (n/10)	% Control	Mean Larval Mass ± SE (mg)	% Damage ± SE
Newly Hatched				
Untreated	5.5±0.6b	0.0	41±10b	11.3±1.3a
Talstar	0.0±0.0a	100.0	0±0a	10.0±2.0a
virus	0.3±0.3a	95.5	6±6a	9.3±1.5a
fungus	1.8±0.9a	68.2	24±9ab	10.0±2.0a
bacteria	2.0±1.2a	63.6	21±14ab	10.0±2.0a
virus + fungus	1.3±1.3a	77.3	6±6a	10.0±2.0a
virus + bacteria	1.5±0.9a	72.7	27±18ab	10.0±0.0a
fungus + bacteria	2.3±1.4a	59.1	14±9ab	11.3±1.3a
2nd & 3rd Instar				
Untreated	8.5±0.6d	0.0	323±22c	52.5±24.5a
Talstar	0.0±0.0a	100.0	0±0a	11.3±3.1a
virus	1.8±1.0ab	79.4	14±9a	8.8±1.3a
fungus	5.8±2.0bcd	32.4	176±88abc	37.5±20.7a
bacteria	3.3±1.9abc	61.8	64±44ab	15.0±5.4a
virus + fungus	1.8±1.4ab	79.4	74±74ab	23.8±15.5a
virus + bacteria	4.5±1.8bcd	47.1	232±84bc	41.3±20.2a
fungus + bacteria	3.5±2.0abc	58.8	151±87abc	46.3±19.9a

Figure 1. Field research plot layout at the Daniel Turfgrass Research and Diagnostic Center**,** Purdue University, West Lafayette, IN, used to evaluate microbial biopesticides for control of black cutworm larvae feeding on bentgrass turf managed under putting green conditions (center). Examples of larval feeding damage after 16 days; A = 2^{nd}-3^{rd} instar untreated, B = 2^{nd}-3^{rd} instar treated, C = newly hatched untreated, D = newly hatched treated.