Turfgrass and Environmental Research Online

...Using Science to Benefit Golf

Black cutworms are considered one of the most serious insect pests on golf course putting greens. Researchers at the University of Wisconsin are investigating plant factors that may be important in developing resistance to the damaging larval feeding behavior of this insect.

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PURPOSE

The purpose of *USGA Turfgrass and Environmental Research Online* is to effectively communicate the results of research projects funded under USGA's Turfgrass and Environmental Research Program to all who can benefit from such knowledge. Since 1983, the USGA has funded more than 290 projects at a cost of $25 million. The private, non-profit research program provides funding opportunities to university faculty interested in working on environmental and turf management problems affecting golf courses. The outstanding playing conditions of today's golf courses are a direct result of ***using science to benefit golf***.

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Identification of Mechanism(s) of Resistance in Kentucky Bluegrass for Control of Black Cutworms

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SUMMARY

The black cutworm is a serious pest of golf course putting greens and tees, consequently multiple insecticide applications are typically required to manage this important pest. In an effort to reduce pesticide use, University of Wisconsin scientists initiated an investigation to identify plant defense mechanism(s) of Kentucky bluegrass that are responsible for inherent resistance to black cutworm. The study's findings include:

- Plant morphological characteristics of Kentucky bluegrasses likely plays an important role in resistance to black cutworm.
- Turfgrass leaf tissue toughness affects development and survival of black cutworm larvae.
- Leaf toughness varies among turfgrass type and plant age.
- Older Kentucky bluegrass leaves are measurably tougher than younger leaves.
- Leaf toughness, neutral detergent fiber (NDF), acid detergent fiber (ADF), and cellulose have a negative affect on weight gain of black cutworm larvae.

The bluegrasses (*Poa spp.*) are a highly diverse group of more than 500 species. Less than nine of these species have desirable characteristics for use as turfgrasses (2). Only three of species are widely used on golf courses throughout the United States and Canada (2): Kentucky bluegrass (*Poa pratensis* L.), annual bluegrass (*Poa annua* L.), and rough bluegrass *(Poa trivialis* L.). The remaining bluegrasses including Supina bluegrass (*Poa supina*), creeping bluegrass (*Bothriochloa insculpta* a.k.a., *Poa annua* cv. *reptans*), Texas bluegrass (*Poa arachnigera*), a hybrid of Kentucky bluegrass and Texas bluegrass (*Poa arachnigera*), Canada bluegrass (*Poa compressa* L.), bulbous bluegrass (*Poa bulbosa* L.), and alpine bluegrass (*Poa alpina* L.) are of relatively limited use. Some of less used bluegrasses are beginning to gain popularity as they have recently been developed, promoted, and marketed.

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Plant Characteristics

Bluegrasses have two common structural characteristics that distinguish them from other turfgrasses: a boat-shaped leaf tip, and folded leaf-blade venation. Apart from these two characteristics, bluegrasses vary greatly morphologically (size and appearance) and physiologically even though they are all from the same genus (*Poa*). Additionally, individual bluegrasses have vastly different growth habits and life cycles. Each species typically requires measurably different management approaches or regimes, including fertility, irrigation and mowing.

Figure 1. Feeding damage from black cutworm larvae

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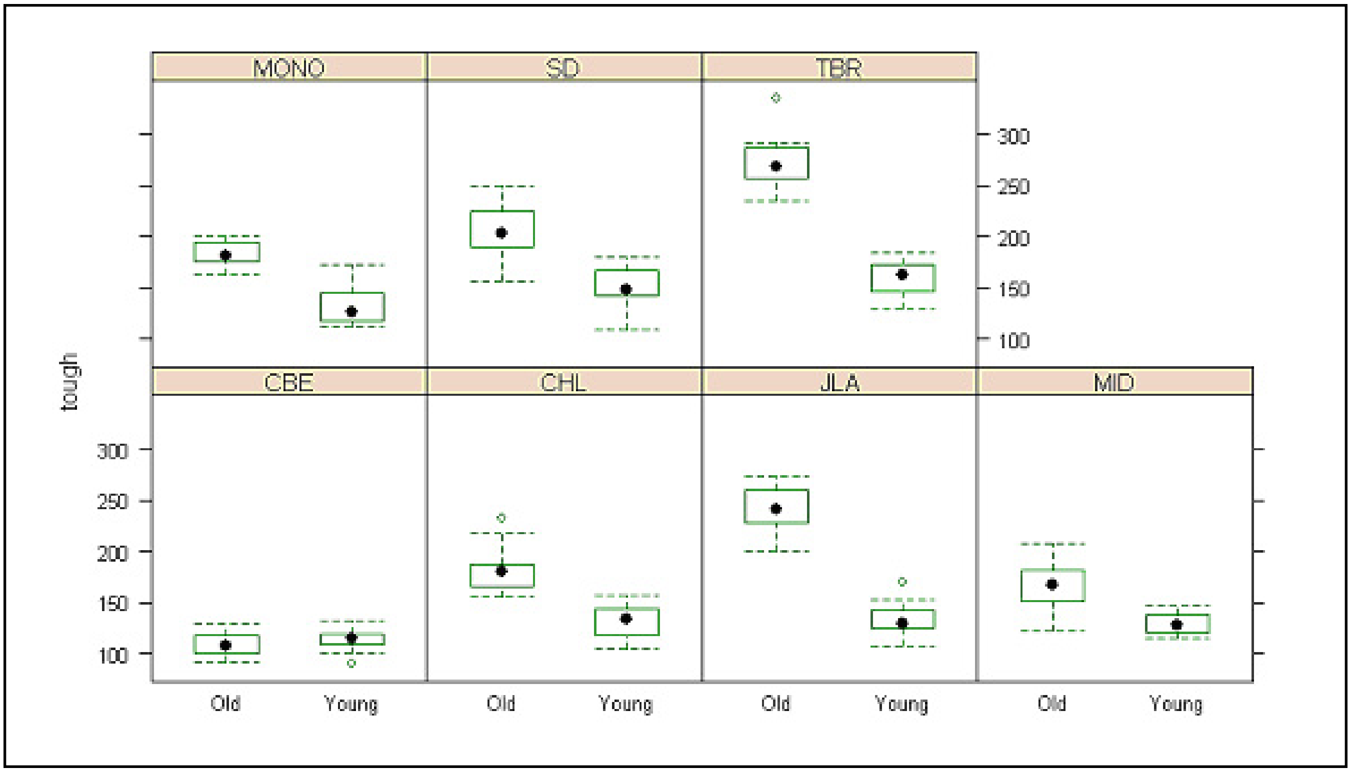

Figure 2. Relationship between turfgrass leaf tissue toughness and plant age. This figure indicates difference of leaf toughness of each turfgrasses with different ages (Young and Old). Creeping bentgrass (CBE) has no difference between young and old plant tissues and relatively lower toughness compared to other grasses. In Kentucky bluegrasses (CHL, JLA, MID, MONO, SD, and TBR), generally leaf tissues was tougher as plants became older.

The Problem

Black cutworm caterpillars are considered the most important insect pest of golf course putting greens, especially greens comprised of creeping bentgrass (3). Feeding damage by black cutworm caterpillars typically results in sunken pockmarks that ultimately interfere with ball roll as well as the overall aesthetics and uniformity of the playing surface (Figure 1). Birds and other animals often cause further damage as they destructively forage for black cutworm caterpillars.

Conventional Management Approaches

Currently, the most common control strategy for the management of black cutworm caterpillars is the use of conventional insecticides. Black cutworm caterpillars are relatively easily and economically controlled by most of conventional (synthetic) and biorational (biologically based) insecticides labeled for golf course turf. Because black cutworm typically has multiple generations per year, and generations frequently overlap one another, several insecticide applications per year are necessary to control the pest. Although pesticides are an integral part of an integrated pest management (IPM) program, whenever possible they should not be the first line of defense or primary control strategy. Considering and implementing alternative, non-chemical control strategies is especially important now because of growing public awareness and concern about the use of pesticides. For this reason, ongoing research has been investigating alternative, non-chemical management approaches for black cutworm caterpillars on golf course turf, especially putting greens.

Alternative Management Approaches

Previously conducted research revealed that most black cutworm eggs are laid on the tips

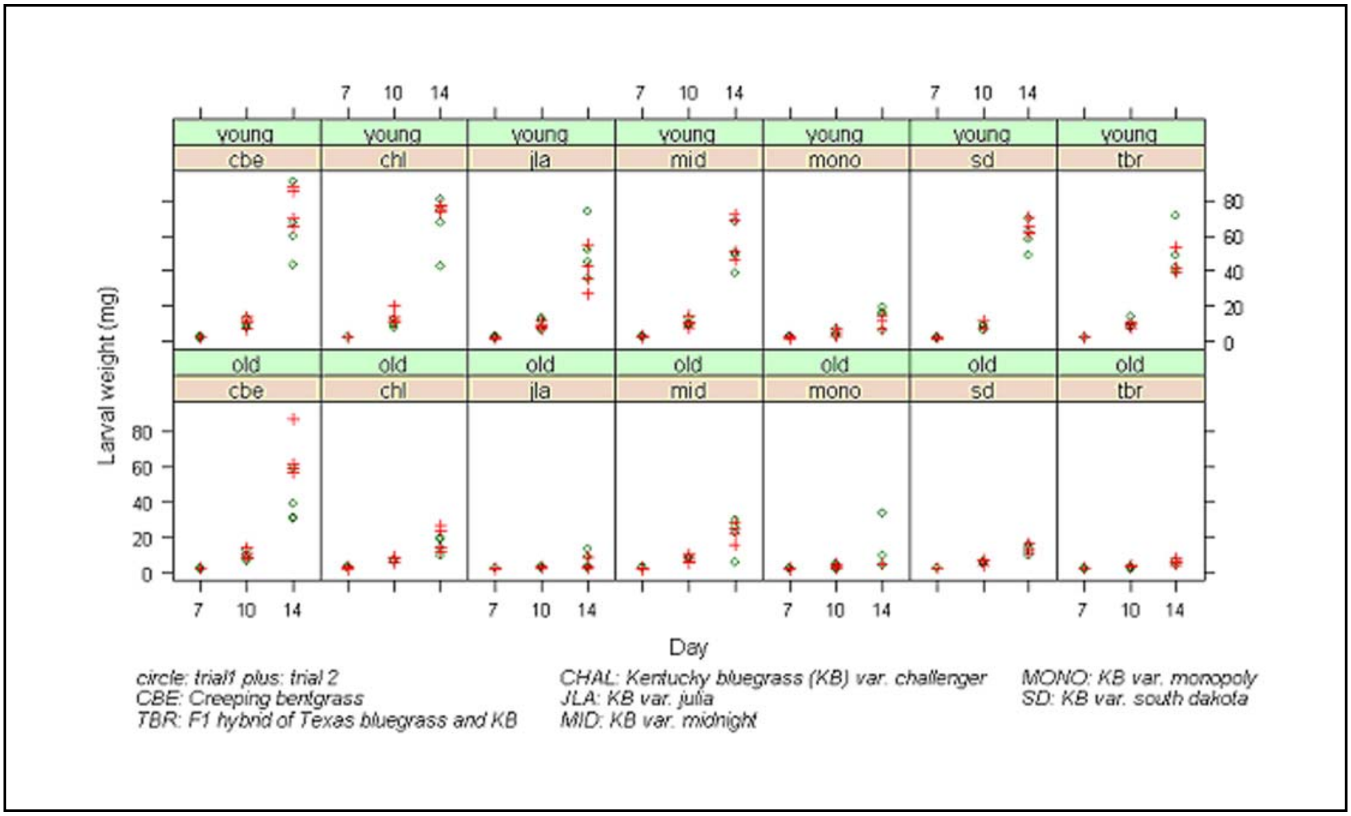

Figure 3. Effect of plant age and turfgrass type on black cutworm larval weight (mg). Feeding assay was conducted using old (greater than 1 yr old after planting seeds) and young (less than 60 days old after planting) plant tissues. Larval weight gain of black cutworm larvae reared on each respective turfgrasses with two different planting age (Young: less than 60 days old after planting and Old: greater than 1 year old after planting) was recorded during 14 days from the beginning of experiment. Two trials were conducted and indicated by circle and plus signs. Each circle or plus sign indicates average larval weight of five black cutworm larvae.

of leaf blades of creeping bentgrass putting greens are removed by daily mowing and clipping removal (4). Williamson and Potter (5) also reported that some cultivars of Kentucky bluegrass exhibited resistance to the development and survival of black cutworm and black cutworm larvae originating from the peripheral area surrounding golf course putting greens.

As a result, it was hypothesized that establishing unsuitable host(s) around putting greens may reduce cutworm infestations on the greens themselves. This hypothesis was put to the test, research results revealed the substantial value in establishing mono-stands of a blend of Kentucky bluegrass cultivars in the peripheral area (i.e., 25 feet) surrounding putting greens. It was determined that black cutworm larval (caterpillar) infestations on golf course putting greens were substantially reduced when greens were surrounded by a stand of predominantly (> 95%) Kentucky bluegrass maintained at > 2 ¼ inches.

It is important to point out that the mowing height of the Kentucky bluegrass was maintained at > 2 ¼ inches. Although seemingly unimportant, this information is most valuable. Mowing can drastically alter the physiological, developmental, and growth responses of turfgrasses (1). As the cutting height of turf is lowered, the following plant responses may occur: 1) decreased carbohydrate synthesis and storage, 2) increased shoot growth per unit area, 3) increased shoot density, 4) decreased leaf width, 5) increased succulence of shoot tissues, 6) increased quantity of chlorophyll per unit area, 7) decreased root growth rate and total root production, and 8) decreased rhizome production (1).

The goal of this research was to attempt to understand the mechanism(s) that may be respon-

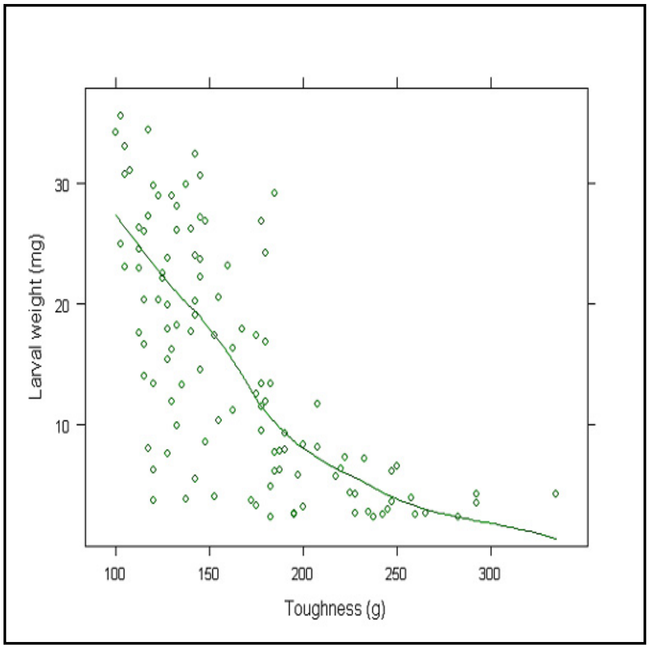

Figure 4. Relationship between turfgrass leaf tissue toughness and black cutworm larval weight (mg).

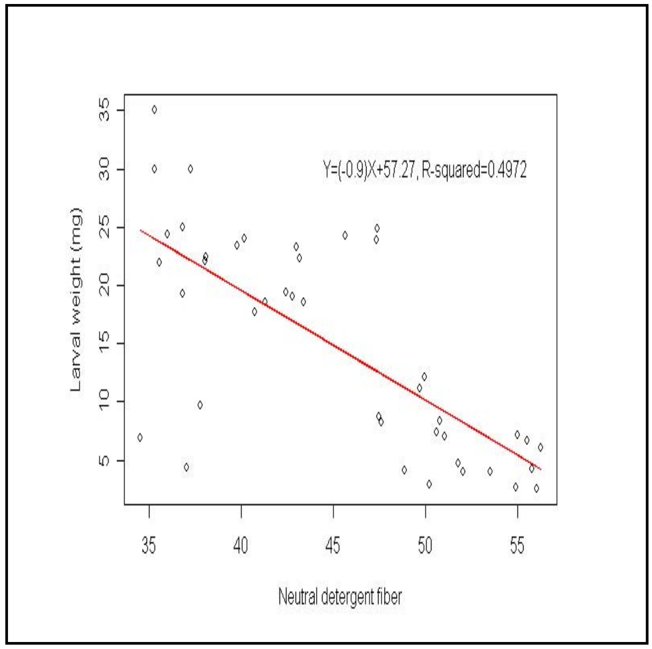

Figure 5. Relationship between neutral detergent fiber (NDF) %/weight and black cutworm larval weight (mg)

sible for the resistance exhibited by Kentucky bluegrass to black cutworm. Such information could be utilized to develop other widely used turfgrass species (including creeping bentgrass) that are resistant to black cutworm.

Recent Research Discoveries

Several experiments were conducted in an attempt to identify the potential mechanism(s) of resistance of Kentucky bluegrass to black cutworm. Initially, experiments were designed to distinguish between two major plant resistance categories: 1) plant morphology (plant architecture) and 2) alleochemistry (plant chemistry). The outcome of various feeding bioassays revealed that plant chemistry (i.e., secondary plant compounds) likely plays a only a limited role in resistance of Kentucky bluegrass to black cutworm, and plant morphology is the most probable mechanism(s) responsible for resistance of Kentucky bluegrass to black cutworm. This important discovery provided valuable insight to refine our research efforts. As a result, we aimed our research at understanding plant morphological characteristics including leaf tissue toughness and structural components of cell walls including neutral detergent fiber (NDF), acid detergent fiber (ANF), and cellulose.

We discovered a strong relationship between the age of turfgrass leaf tissues and toughness as measured by a leaf penetrometer. Old turfgrass leaf tissue of Kentucky bluegrass cv. 'Challenger' and 'Julia' as well as the Kentucky bluegrass and Texas bluegrass hybrid 'Reveille' had significantly tougher leaf tissues than young turfgrass leaf tissue (Figure 2). Larval feeding bioassays revealed that black cutworm larval weight was significantly greater on young turfgrass tissues compared to old (Figure 3).

Generally, when comparing all turfgrasses, a distinct relationship between larval weight and turfgrass tissue toughness was observed (Figure 4). A comparable relationship also occurred between NDF, ADF, and cellulose and larval weight; as the amount (percent content by weight) of NDF, ADF, and cellulose increased, black cutworm larval weight (mg) dramatically decreased (Figures 5, 6, and 7, NDF, ADF, and cellulose, respectively).

These structural components of cell walls all play an important role in the physical structure

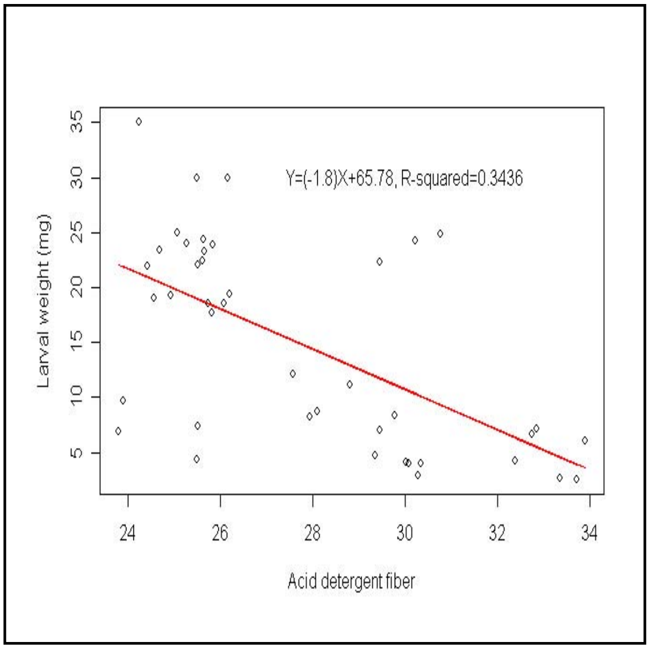

Figure 6. Relationship between acid detergent fiber (ADF) %/weight and black cutworm larval weight (mg)

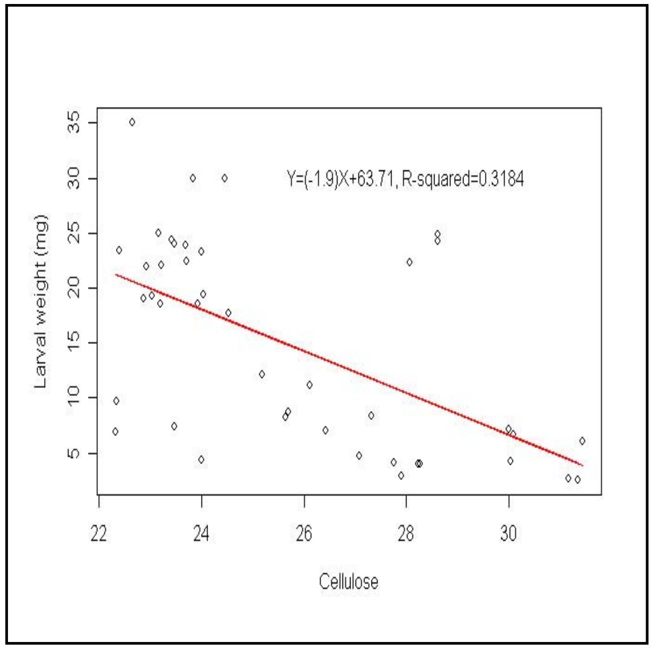

Figure 7. Relationship between cellulose %/weight and black cutworm larval weight (mg)

(architecture) and digestibility of plant tissue. Moreover, dry matter and digestibility have been negatively correlated with NDF and ADF. Collectively, these results support our proposed theory that lower-cut Kentucky bluegrass may provide suitable plant tissues for the development and survival of black cutworm due to increased succulent leaf tissue as reported by Beard (1).

Implications of Research Findings

Based on the results of our investigation, it is apparent that plant tissue morphology (architecture) plays a predominant role in the resistance exhibited by Kentucky bluegrass to black cutworm. More specifically, turfgrass leaf tissue toughness directly influences the development and survival of black cutworm larvae; succulent (less tough) plant tissues are more likely to support the development and survival of black cutworm.

Previous research suggests that the use of resistant cultivars of Kentucky bluegrass in the peripheral area surrounding putting greens is an effective management strategy for reducing black cutworm populations on putting greens. We theorize that maintaining resistant Kentucky bluegrass cultivars at higher (> 2 ¼ inches) cutting heights may increase the proportion of older, tougher leaf tissues, thus decreasing the likelihood of black cutworm development and survival. This proposed management strategy coupled with the removal of black cutworm eggs on putting greens via daily mowing and clipping removal will greatly reduce the likelihood of black cutworm caterpillars on putting greens. Consequently, the need for the application of conventional insecticides to manage black cutworm will be dramatically reduced.

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