Efficacy of Five Insecticides Targeting Spring and Fall Populations of Sugarcane Beetle Adults

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Efficacy of five insecticides targeting spring and fall populations of sugarcane beetle adults

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Sugarcane beetle (*Euetheola rugiceps* LeConte) (Coleoptera: Scarabaeidae) is historically a pest in agricultural crops such as sugarcane and corn (Comstock 1881; Howard 1888) but has recently been reported to be a pest of turfgrasses in the southeastern United States (Billeisen & Brandenburg 2014, 2016). Adults are typically found feeding on warm-season turfgrasses such as bermudagrass (*Cynodon* species) and zoysiagrass (*Zoysia* species) (Poaceae).

Sugarcane beetles emerge at 2 distinct times of the year and cause damage to the turf by consuming aboveground plant tissue and by tunneling through the soil profile, causing ridges in the turf surface. Sugarcane beetles do not spend the majority of their life cycle as larvae, unlike other white grub species. They overwinter as adults and begin emerging in late Mar (spring population) in North Carolina. Spring beetles are responsible for the majority of damage seen in both agricultural crops (Fox & Phillips 1917; Phillips & Fox 1924) and turfgrass (Billeisen & Brandenburg 2014). Adults fly, mate, and lay eggs through Jun (Billeisen & Brandenburg 2016). Larvae and pupae are present in the soil in Jun, Jul, and Aug. Adults (fall beetles) emerge from pupae and are active from Sep to Nov. Although this population is smaller (0–80 adults per light trap catch per week compared with 200–500 adults per light trap catch in the spring) and exhibits less flight activity, fall adults typically survive several days longer in the laboratory than spring adults (Billeisen & Brandenburg 2016).

This study compares the efficacy of 5 commercial insecticides on sugarcane beetle adults under greenhouse conditions. The adult life stage is difficult to control due to its mobility and ability to tunnel in the soil. However, targeting adults is an important aspect of management because sugarcane beetles spend the majority of their life cycles as adults, and unlike many turfgrass pests, the adult life stage is the most damaging. Strategies for adult control are therefore the most likely to be implemented by turfgrass managers, and options for adult control must be explored. Insecticides were used to target both spring and fall beetles, to identify not only the appropriate products for sugarcane beetle control but also the time of year the beetles are most susceptible. This research focused on creating a more comprehensive management strategy to control sugarcane beetle adults when infestations occur at damaging levels.

Sugarcane beetle adults were collected weekly from light traps or hand-picked from a bermudagrass turfgrass stand surface at night at the North Carolina State University Lake Wheeler Field Laboratory. Beetles were sexed and stored separately in sterilized potting soil (Scotts Miracle-Gro Company, Marysville, Ohio) for a maximum of 12 h prior to onset of a trial.

Bermudagrass (*Cynodon* sp.) was grown from seed in approximately 16 × 16 × 12 cm white plastic containers (Berry Plastics Corp., Evansville, Indiana) in the greenhouse at the North Carolina State University Method Road Greenhouse Complex. Containers were filled with a 50:50 sterilized sand:sterilized potting soil mixture (Scotts Miracle-Gro Company, Marysville, Ohio) and watered until the soil mixture was saturated. Grass seed was applied (9 g/m^2) to the soil surface and then lightly covered (about 0.6 cm) with sterilized potting soil. Containers received irrigation (about 0.6 cm) daily until germination occurred. Following germination, containers received irrigation (0.6 cm) every 3 d. Grass was maintained at a height of 5 cm by using handheld grass shears (No. GS500, Black & Decker®, Towson, Maryland) for the remainder of the study.

Products were tested at the lowest label rate and the highest label rate for turfgrass pests. To test the products at the low rate against 2 distinct sugarcane beetle populations, insecticide trials were conducted at 2 times of the year: against beetles emerging in spring–early summer and beetles emerging in the fall. This was repeated to produce 3 replications of both spring and fall populations. An additional insecticide trial examined these same control products at the high field rate on the spring adult population. This trial was repeated for a total of 4 replications. Insecticides evaluated in this experiment included bifenthrin (Talstar® L, FMC Corporation, Philadelphia, Pennsylvania), 80 g/L; the combination product bifenthrin + clothianidin (Aloft® GC SC, Arysta LifeScience, Cary, North Carolina), 130 g/L (bifenthrin) and 260 g/L (clothianidin [BC]); carbaryl (Sevin® SL, Bayer, Germany), 480 g/L; clothianidin (Arena® 50WDG, Valent, Walnut Creek, California); and dinotefuran (Zylam®, PBI-Gordon, Kansas City, Missouri), 100 g/L. Formulated products were diluted in 500 mL water and adjusted to produce the required concentrations (Table 1).

Insecticides were applied with plastic, handheld, 0.95 L trigger spray bottles (Zep Commercial, Marietta, Georgia). Spray nozzle volume was measured with a graduated cylinder prior to application, and the number of spray bottle trigger compressions to the turfgrass surface to deliver the correct amount of active ingredient was calculated. Following insecticide application, plants were sprayed with 10 mL (10 compressions) of water from a previously pesticide-unexposed bottle.

Table 1. Insecticide treatment application rates (per 92.9 m^2) used on sugarcane beetle adults in the greenhouse. See Materials and Methods section for concentrations.

Treatment	Low rate	High rate
bifenthrin	14.80 mL	29.60 mL
bifenthrin + clothianidin (BC)	7.98 mL	16.00 mL
carbaryl	88.70 mL	177.00 mL
clothianidin	4.34 mL	8.68 mL
dinotefuran	29.60 mL	52.60 mL

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Plants remained undisturbed for 5 min before beetles were introduced to the containers. Five sugarcane beetle adults were added to each container. Each container was covered with a layer of tulle secured with 2 rubber bands. Following application, containers received 2 rounds of light irrigation (about 0.4 cm) via the mist setting on a hand-held water wand (Orbit Irrigation Products®, Bountiful, Utah). Treatment efficacy was determined 7 d after treatment. Containers were destructively sampled and insect mortality was recorded. Adult beetles were considered dead if they remained unresponsive to light tapping with a pencil on the dorsal side of the thorax.

Adult beetle mortality was summarized as percentage of mortality per container for each sampling date. Data were corrected in containers with less than 100% individual recovery by using the Sun–Shepard's formula (Püntener 1981) that adjusted for control mortality in non-uniform populations. Data were $\sqrt{(x + 0.5)}$ transformed and analyzed by 1-way ANOVA. Means were separated at the 5% significance level by Fisher's LSD (SAS Institute 2014).

Results showed that spring populations of sugarcane beetles were more susceptible to insecticide control than fall populations ($F_{1,142} = 41.74$; $P \leq 0.0001$) (Fig. 1). However, there was a difference among treatments of fall beetle populations ($F_{17,54} = 4.95$; $P < 0.0001$) with bifenthrin having significantly greater control (mean of 34.4%) than all other products. Containers that received an insecticide application had significantly higher mean percentage of mortality than untreated (control) containers at both the low rate ($F_{17,54} = 2.76$; $P = 0.0024$) and the high rate ($F_{23,72} = 2.49$; $P = 0.0018$), but no significant differences were detected among insecticides when applied to spring beetles at either rate (Fig. 2). Mean percentage of mortality did not increase significantly when the application rate was doubled.

Product choice and application rate were not as important as application timing for suppressing a sugarcane beetle population. All products were more efficacious against spring beetles than fall beetles. For example, containers with spring beetles that received a low-rate bifenthrin treatment had 58% mean percentage of mortality whereas containers with fall beetles that received the same treatment had 34% mean percentage of mortality. One possible explanation for the observed difference in control between the 2 populations is that low temperatures in the winter could impose fitness costs to the overwintering adult populations (Billeisen & Brandenburg 2014). Overwintered beetles held in the laboratory did not survive as long as beetles that emerged in Aug and Sep. Fall-emerging beetles could be held in the laboratory with no observed negative effects for at least 7 d.

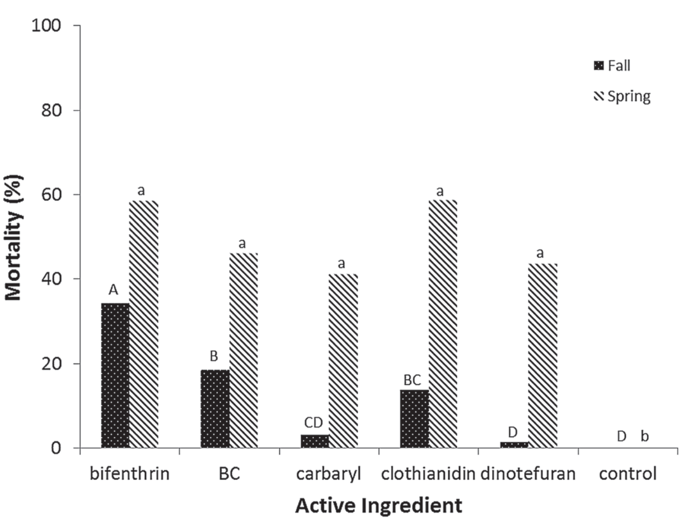

Fig. 1. Adjusted percentage of mortality of fall and spring populations of sugarcane beetles by active ingredient at low label rate. Treatment means with different upper case letters are significantly different ($P \leq 0.05$; ANOVA and LSD test) for the fall population. Treatment means with different lower case letters are significantly different ($P \leq 0.05$; ANOVA and LSD test) for the spring population.

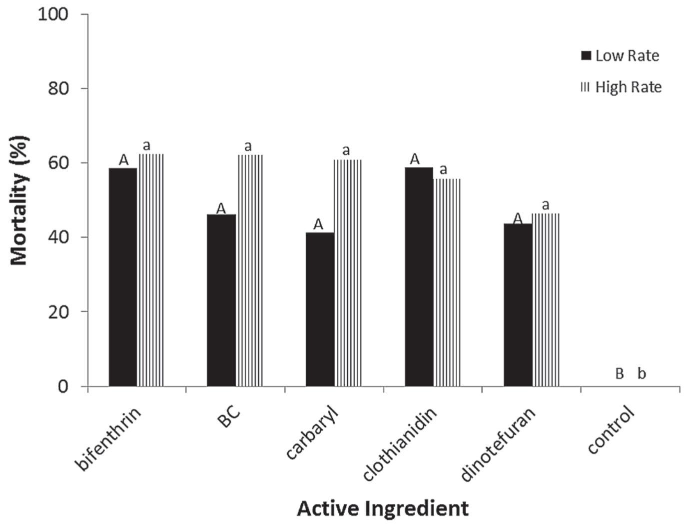

Fig. 2. Adjusted percentage of mortality of spring sugarcane beetles by active ingredient at both low and high label rate. Treatment means with different upper case letters are significantly different ($P \leq 0.05$; ANOVA and LSD test) at the low rate. Treatment means with different lower case letters are significantly different ($P \leq 0.05$; ANOVA and LSD test) at the high rate.

This study illustrates the potential of 5 insecticides to control 2 temporally distinct populations of sugarcane beetle adults. As these insects spend the majority of their life cycle as an adult and because sugarcane beetle infestations are difficult to predict, it is essential to know which products are most appropriate for control. This research has demonstrated that percentage of control does not appear to be significantly increased with higher application rates and that effective management of this pest will rely heavily on correct application timing. Overwintering adult populations emerging in late spring and early summer are more susceptible to insecticide control compared with fall-emerging adults. Early (May–Jun) applications of control products may be most successful at controlling sugarcane beetle infestations.

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Summary

Sugarcane beetle (*Euetheola rugiceps* LeConte; Coleoptera: Scarabaeidae) is a pest of turfgrass in the southeastern United States. This study was conducted to evaluate the toxicity of 5 products for sugarcane beetle pest management in managed bermudagrass (*Cynodon dactylon* L.; Poaceae). Spring and fall populations of sugarcane beetle adults were exposed to 4 active ingredients and combinations (bifenthrin, bifenthrin plus clothianidin, carbaryl, clothianidin, and dinotefuran) under greenhouse conditions. At 7 d after treatment, there were no significant differences among insecticide treatments applied to spring beetles at either a low or a high field rate, although all insecticides caused a significant increase in beetle mortality relative to untreated (control) beetles. In contrast, bifenthrin caused significantly greater control of fall populations at the low field rate compared with other treatments. Target population (spring or fall) appears to have more impact on pesticide efficacy than either product selection or application rate.

Key Words: *Euetheola rugiceps*; chemical control; IPM; turfgrass

Sumario

El escarabajo de la caña de azúcar (*Euetheola rugiceps* LeConte; Coleoptera: Scarabaeidae) es una plaga del césped en el sureste de los Estados Unidos. Se realizó este estudio para evaluar la toxicidad de 5 productos para el control del plaga escarabajo de la caña de azúcar en el manejo del pasto de Bermuda (*Cynodon dactylon* L; Poaceae) manejado. Las poblaciones de adultos del escarabajo de la caña de azúcar de la primavera y el otoño fueron expuestos a 4 ingredientes activos y combinaciones (bifentrina, bifentrina más clotianidina, carbaril, clotianidina y dinotefurano) bajo condiciones de invernadero. En 7 dias después del tratamiento, no hubo diferencias significativas entre los tratamientos insecticidas aplicados a los escarabajos de la primavera, ya sea en una tasa de campo baja o alta, a pesar de todo los insecticidas causaron un aumento significativo en la mortalidad del escarabajo en relación con los escarabajos (de control) no tratados. Por el contrario, bifentrina resultó en un control de las poblaciones del otoño significativamente mayor con una tasa de campo baja en comparación con los otros tratamientos. La población objetivo (primavera u otoño) parece tener un mayor impacto sobre la eficacia de los pesticidas que entre la selección de productos o la tasa de aplicación.

Palabras Clave: *Euetheola rugiceps*; control químico; MIP; césped

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