EFFECTS OF TWO PLANT GROWTH REGULATORS ON SUITABILITY OF CREEPING BENTGRASS FOR BLACK CUTWORMS AND SOD WEBWORMS

M. E. Rogers, D. W. Held, D. W. Williams, and D. A. Potter

ABSTRACT

Plant growth regulators are often used on turfgrass to reduce mowing frequency and grass clippings, increase root growth and stress tolerance, and suppress seed head formation. Given their effects on grass physiology, which include changes in plant nutritional value and production of plant allelochemicals, use of plant growth regulators might be expected to affect suitability of treated grass as food for turfgrass insects. Effects of two plant growth regulators, trinexapac-ethyl and paclobutrazol, on survival and growth of sod webworms (Pyralidae), the black cutworm, *Agrotis ipsilon* Hufnagel, and Japanese beetle grubs, *Popillia japonica* Newman, in creeping bentgrass, *Agrostis stolonifera* L., were determined. Our results indicate that monthly use of trinexapac-ethyl or paclobutrazol on creeping bentgrass mowed at golf fairway height is unlikely to increase or decrease problems with turf-infesting caterpillars. Conclusions could not be made for effects on *P. japonica* because of low numbers of grubs at our study site.

Keywords

Agrotis ipsilon; host plant resistance; paclobutrazol; *Popillia japonica*; Pyralidae; trinexapac-ethyl

INTRODUCTION

Mowing is necessary to maintain topgrowth of turfgrass, control undesired vegetation, and sustain recreational turf [Turgeon, 1999]. Frequent mowing, especially at low mowing heights, stresses turfgrass by removing tissues needed for carbohydrate production, making turf more susceptible to disease and lowering its ability to compete with weeds [Christians, 1998]. Much of the mowing stress to turfgrass, as well as clippings and labor inputs, can be reduced by applications of plant growth regulators (PGRs). Additionally, applications of PGRs such as fluprimidol and paclobutrazol may be used to reduce populations of annual bluegrass, *Poa annua* L. [Christians, 1998].

PGRs used in turf alter plants physically by reducing shoot elongation. They also cause biochemical alterations including changes in levels of protein and amino acids and production of allelochemicals [Campbell, 1988]. Use of PGRs has increased in the past decade in many agricultural systems with the intent of not only increasing plant vigor, but also controlling pest insects [Campbell, 1988; Turgeon, 1999]. For example, in a study aimed at controlling pear psylla, *Psylla pyricola* Foerster, daminozide was used to control shoot growth on pear trees, thus reducing the population of pear psylla while increasing fruit yield [Westingard et al., 1980]. Other studies have shown that application of gibberellic acid reduced numbers of mites, aphids, and grasshoppers but increased larval weights of the silkworm, *Bombyx mori* (L.) [Campbell, 1988].

The PGRs paclobutrazol and trinexapac-ethyl are commonly used for turfgrass applications. Both are Type II, or gibberellic acid, inhibitors that reduce stem elongation. They may also serve to increase root mass and cause turf to transpire less, therefore conserving soil moisture [Brueninger and Watschke, 1989]. Given the physiological and morphological changes that PGRs induce in turfgrass, it is possible that these changes may affect the suitability of treated turf as a food source for turf-infesting insects. This study examined this possibility for selected pests of creeping bentgrass turf.

MATERIALS AND METHODS

Replicated field plots (5 × 5 m) were established in April 1999 on a stand of 'Penncross' creeping bentgrass seeded in fall 1992 at the University of Kentucky Spindletop Research Farm, Lexington, KY. The soil was a Maury silt loam with a pH range of 6.3 - 6.9. Treatments included: Turf Enhancer 2SC (Scotts, Marysville, OH), containing 22.3% paclobutrazol; Primo Liquid (Novartis, Greensboro, NC), containing 12.0% trinexapac-ethyl; and an untreated control. Each treatment was replicated six times in a randomized complete

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block design. Each PGR was applied at label rate (0.3 kg AI/ha), monthly from May through August. Plots were mowed at 1.9 cm height, about three times per week, and were irrigated to prevent drought stress, generally 0.6 cm per day.

Effects on Natural and Augmented Caterpillar Infestations

Monthly attempts to sample the natural cutworm population using soap drenches (Ultra Joy™; Proctor and Gamble, Cincinnati, OH; 10 ml per 7.6 liters of water) indicated that few cutworms were present at our study site. By mid-summer, however, the turf had become heavily infested with larvae of an unidentified sod webworm (Pyralidae) which, on the basis of adult flights, was probably *Parapediasia teterrella* (Zincken). These larvae had not surfaced when the aforementioned soap drenches were applied, but were sampled effectively using a dilute drench of Safer Yard and Garden Insect Killer™ (Verdant Brands, Bloomington, MN) which contains 0.24% pyrethrins and 20% potassium salts of fatty acids. The drench consisted of 5 ml of product per 7.6 liters of water. Plots were re-sampled for sod webworms on 26 August 1999. All larvae collected were placed in a cooler and immediately taken to the lab. Number and weight of larvae recovered per m^2 were recorded for each plot and analyzed by two-way analysis of variance (ANOVA) using Statistix for Windows [Analytical Software, 1998].

Due to low natural densities, we evaluated the impact of PGR treatments on black cutworms by augmenting populations with lab-reared larvae obtained as eggs from M. Jackson (University of Missouri, Columbia, MO). On 1 September 1999, 20 second instars were placed into a PVC ring (38.98 cm diam × 10.16 cm height) that had been driven into each plot to a depth of ~6.5 cm. Rings were then covered with netting with a mesh size of 2.54 cm to reduce avian predation. Fourteen days later, the turf within each enclosure was sampled with a soap drench (10 ml of Ultra Joy™ per 7.6 liters of water) and all larvae that surfaced were collected, counted, and weighed. Mean weights and total larval numbers per plot were analyzed for treatment effects by two-way ANOVA as before. Where significant treatment effects were noted, means for each PGR treatment were compared with the control by single degree of freedom orthogonal contrasts at $P < 0.05$.

Growth and Survival of Black Cutworms on Grass Clippings

Possible effects of PGRs on growth and survival of black cutworms were further studied by rearing larvae on clippings from the PGR-treated or untreated creeping bentgrass plots. Two trials were conducted. Trial 1 ran from 23 June to 7 July 1999; Trial 2 ran from 13 to 17 July 1999. Within each trial, newly emerged first instars were confined individually in plastic petri dishes containing moistened dental wick and filter paper. Grass clippings were collected from each field plot using hand shears, placed in plastic bags, and taken to the lab in a cooler. Each larva was fed fresh clippings from an assigned field plot. There were 10 larvae per plot, with six replicate plots, totaling 60 larvae reared on each treatment. Petri dishes were held in a growth chamber at 25°C ± 5°C with a photoperiod of 14:10 (L:D). Fresh clippings were provided every 2 days and larval survival and weight were assessed at 7 and 14 days after introduction. Weights of surviving larvae were averaged within each plot; mean weights and number of surviving larvae then were analyzed for treatment effects by two-way ANOVA as before.

Effects on *P. japonica* Grubs

Open bottom screen cages (0.3 × 0.3 × 0.3 m)

Table 1. Mean (± SE) weight and survival of black cutworms that were reared from the first instar on clippings from PGR-treated or untreated creeping bentgrass plots.

		After 7 days		After 14 days	
Treatment	Rate kg AI/ha	Weight per larva (mg)†	No. surviving‡	Weight per larva (mg)	No. surviving
Trial 1					
Control	–	57.3 ± 8.6	8.8 ± 0.4	337.1 ± 74.5	4.5 ± 1.3
Trinexapac-ethyl	0.3	54.4 ± 7.8	9.0 ± 0.5	423.4 ± 21.2	7.1 ± 0.8
Paclobutrazol	0.3	47.6 ± 5.8	9.2 ± 0.5	358.2 ± 17.4	6.3 ± 6.2
Trial 2					
Control	–	15.5 ± 1.8	8.7 ± 4.2	329.6 ± 29.5	6.5 ± 0.6
Trinexapac-ethyl	0.3	13.5 ± 1.4	9.2 ± 6.5	330.8 ± 43.8	7.7 ± 1.0
Paclobutrazol	0.3	16.2 ± 1.5	9.5 ± 3.4	340.9 ± 24.4	7.7 ± 0.6

† Larval weights do not differ significantly among treatments within either trial. For Trial 1, $F = 2.13, 1.08$; df = 2,10; $P = 0.17, 0.38$ for 7 and 14 days, respectively). For Trial 2, $F = 1.23, 0.03$; df = 2,10; $P = 0.33, 0.97$ for 7 and 14 days, respectively.

‡ Based on 10 initial larvae per replicate. Numbers surviving do not differ significantly among treatments within either trial. For Trial 1, $F = 0.14, 1.98$; df = 2,10; $P = 0.87, 0.19$ for 7 and 14 days, respectively). For Trial 2, $F = 0.80, 0.76$; df = 2,10; $P = 0.48, 0.49$ for 7 and 14 days, respectively.

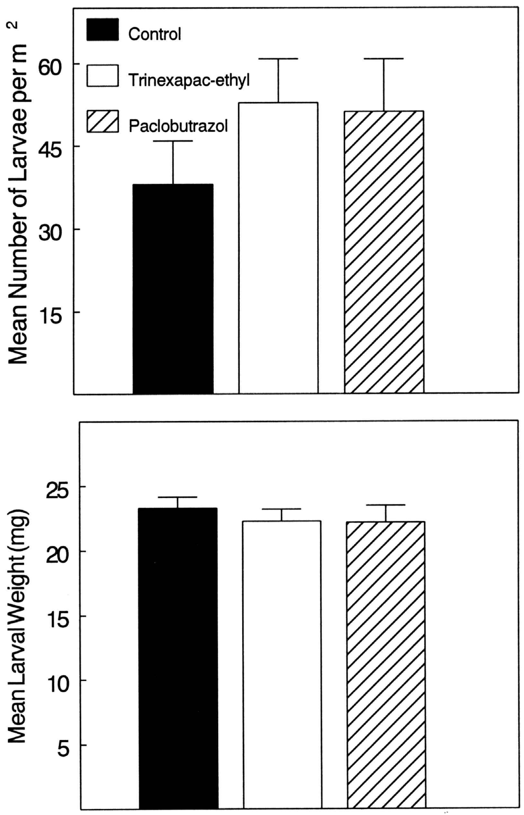

Figure 1. Mean number of sod webworms per 1 m^2 (upper graph) and weight (mg) per larva (lower graph) for drench samples taken from PGR-treated or untreated creeping bentgrass plots on 26 August 1999.

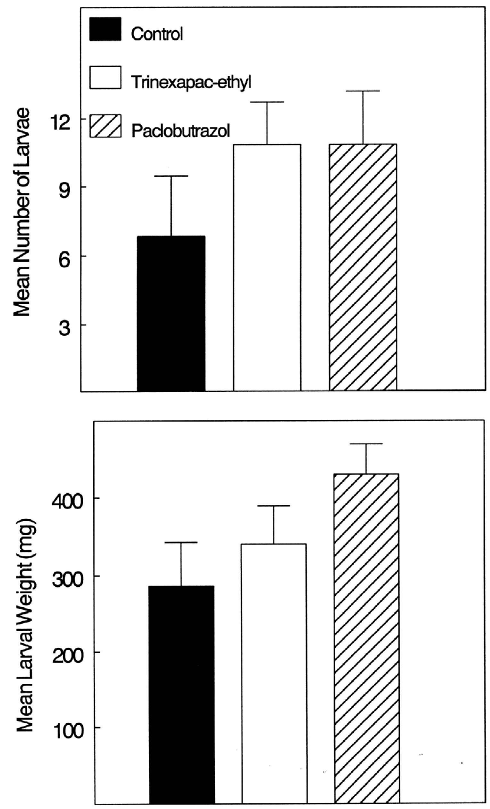

Figure 2. Mean number of black cutworms per 38 cm diameter enclosure (upper graph) and weight (mg) per larva (lower graph) in soap drench samples taken on 15 September 1999. Each enclosure had been augmented with 20 second instars 2 weeks earlier.

were placed on each plot during the first week of July 1999. Twenty mated, field-collected female Japanese beetles were added to each cage to lay eggs that would augment the natural population of grubs. Three separate locations within each plot were chosen for inoculation. One location per plot was inoculated each day for 24 h. This was repeated with fresh beetles on different locations in each plot for the following two days. The areas of inoculated turf were then sampled with a spade at the end of August and all grubs present were collected, identified, and counted.

RESULTS

Effects on Natural and Augmented Caterpillar Infestations

Naturally-occurring sod webworms were abundant, averaging about 35 to 50 larvae per m^2 when the turf was sampled with drenches in late August. There was no significant treatment effect for either total number of sod webworms, or mean weight per larva (F = 0.83 and 0.57; df = 2,10; P = 0.46, 0.58; respectively; Fig. 1).Recovery of augmented black cutworms was > 60% across all treatments. There was no difference among treatments for total larvae recovered (F = 0.88; df = 2,10; P = 0.44), but there was a significant treatment effect for mean larval weight (F = 4.27, df = 2,10, P = 0.046, Fig. 2). Larvae from paclobutrazol-treated plots were heavier than those from control plots (orthogonal contrasts, t = 2.89, P = 0.016) but there was no difference between trinexapac-ethyl-treated plots and controls (t = 1.10, P = 0.30).

Growth and Survival of Black Cutworms on Grass Clippings

Within each trial, the percentage of larvae surviving after 7 or 14 days was similar across treatments regardless of whether the cutworms were fed clippings from PGR-treated or control plots. Similarly, there was no significant treatment effect on larval weight (Table 1). There was, however, a marked difference in 7-day larval weights between the two trials. Reasons for this difference are uncertain, but it may have been due to slightly higher initial weights of the larvae used in the first trial.

Effects on *P. japonica* Grubs

No Japanese beetle grubs were recovered at the inoculation sites on any of the plots. A small number of grubs of the black turfgrass ataenius, *Ataenius spretulus* (Haldeman), and masked chafers (*Cyclocephala* spp.), were present but their low populations precluded meaningful statistical analysis.

CONCLUSIONS

Abundance and mean weight of naturally occurring sod webworms did not differ significantly between untreated and PGR treated creeping bentgrass plots. There also was no treatment effect on survival of implanted black cutworms, although larvae recovered from paclobutrazol-treated plots were heavier than those from controls. Seemingly, this difference was not related to the nutritional quality of the grass itself, because weight gain and survival of black cutworms was similar for larvae reared on clippings from PGR-treated or untreated plots. Results of this study suggest that monthly use of the PGRs trinexapac-ethyl or paclobutrazol on creeping bentgrass golf fairways is unlikely to have any significant impact on population densities of these turf-infesting caterpillars. We were unable to assess PGR effects on scarabaeid grubs because of low natural populations and apparent failure of caged Japanese beetles to oviposit in the plots.

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