(less than 1 percent). All of the life stages were rated on a 0 to 5 activity scale, where 0.0 = no activity after 10 seconds, 2.5 = insect moving slowly, and found deeper in soil profile, and 5.0 = insect moved as soon as exposed.

Results

Activity Rating: In this trial, the activity rating was our measure of the impact of the treatments on the insect movement and viability (Table 1). At the 2 DAT rating, Dylox had the greatest reduction in ABW larvae activity in the pulled plugs. Although not significantly different from the untreated control plots, all plots treated with Dursban or Provaunt had the highest activity ratings. At 4 DAT, no significant differences were observed among the treated insecticide plots and the untreated plots. By 7 DAT, all insecticide-treated plots showed a reduction in movement of the ABW larvae. The highest reduction in the activity of the ABW was observed in plots treated with Dylox, followed by Provaunt or Meridian. By 12 DAT, all ABW activity in the insecticide treated plots was significantly less (i.e., 0.0-0.3), when compared to the untreated plots (1.3). Complete control (i.e. no visual movement of any ABW) was observed in plots treated with Provaunt.

Turfgrass Quality: At 2 DAT, all insecticide-treated plots had a slightly higher turfgrass quality, although not statistically higher than the untreated control. That trend continued on 4 and 7 DAT. No significant differences in turfgrass quality were observed among the insecticide treatments until 12 DAT. It is important to note that the turfgrass quality in the untreated plots was nearly the same at 12 DAT as it was at 2 DAT, and generally all of the treated plots had higher quality.

Data from this study indicate that superintendents making curative (i.e., rescue) treatments targeting the ABW larvae that are actively feeding need to be patient following the application. In this study, we first observed a significant decline in the movement and feeding (as indicated by turfgrass quality and recovery) on 4 to 7 DAT rating dates. The top three performers over the 12 days of evaluation, based on turfgrass quality and activity rating, were Dylox, Meridian and Provaunt. Dylox has previously been reported to provide greater than 80 percent control of ABW larvae.

This study supported many field observations in which ABW larvae, pupae and callow adults continue to move and might or might not stop feeding following an insecticide application. In this trial, we observed some differences among treatments in the quickest knockdown. It is important to note that many other insecticides could have been included [i.e., Conserve (spinosad), Merit (imidacloprid), Arena (clothianidin) and others] in this one-year field study. However, we did not have them available at the initiation of this study.

Conserve has been shown to provide excellent curative control (over 90 percent) of the ABW larvae in many studies throughout the Northeast region. It is also important to note that the level of damage observed in this study should be considered severe. After 12 days of rating, the turfgrass quality in all of the plots (insecticide-treated and untreated) was still unacceptable (below 7.5).

Hence, it is best for superintendents to target this pest on a preventive basis using a combination or rotation of materials for resistance-management programs.

Steven McDonald, M.S., is the principal in Turfgrass Disease Solutions LLC. Daniel Biehl is a student intern at the Pennsylvania State University.

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Sprayable Sex Pheromones Disrupt Oriental Beetle Mating

By Albrecht M. Koppenhöfer

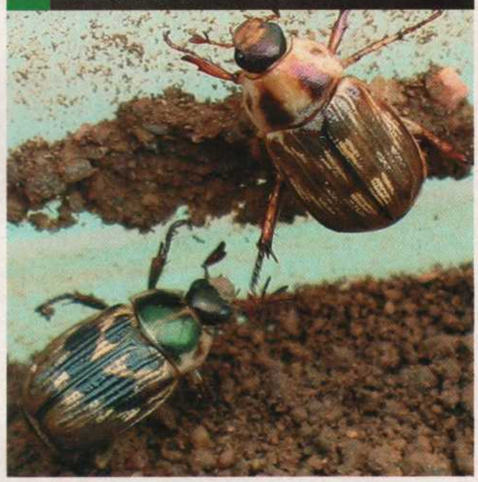
The oriental beetle (OB), *Anomala orientalis*, has become the most important white grub species in turfgrass in New Jersey, southeastern New York, Connecticut and Rhode Island. It is also the major white grub species in ornamental nurseries and blueberries, and it causes losses in other crops. An increase in OB significance may occur in other areas where it is already established, such as all of coastal New England and Middle Atlantic states as well as Ohio, Virginia, North Carolina, South Carolina, West Virginia and Tennessee.

The OB has a one-year life cycle similar to that of other important white grub species. At the latitude of New Jersey, OB flight occurs from early June through early August with peak flight activity in late June/early July. The adult beetles only live for about two weeks and do not cause significant damage. After mating, the females lay eggs among the roots of host plants, and the eggs hatch in two to three weeks. The first and second instar each last around three weeks so that by mid-September the majority of the larvae are in the third instar.

After overwintering below the frost line, the third instars resume feeding until pupation in late spring. The extensive feeding activity of the larger larvae can kill large areas of grass from mid-August into mid-October, especially under warm, dry conditions. In addition, vertebrate predators can tear up the turf to feed on the grubs.

Sex pheromone-mediated mate finding and copulation of OB occur at or near the soil surface, immediately after female emergence from the soil, close to the emergence site (Facundo et al. 1999a, b). Males respond to female-released pheromone by a combination of flying upwind and walking short distances. Both sexes are most active between 6 p.m. and 10 p.m. The OB sex pheromone consists of 9:1 blend of (Z)-7-tetradecen-2-one and (E)-7-tetradecen-2-one (Zhang et al. 1994, Facundo et al. 1994).

PHOTO 1



A male oriental beetle (bottom) persues a female. The adult beetles only live for about two weeks and do not cause significant damage.

Mating disruption with sex pheromones is widely used as an environmentally safe, nontoxic alternative to broad-spectrum insecticides for several moth species (Cardé and Minks 1995). But only recently has mating disruption technology been considered a possibility for management of white grubs (Polavarapu et al. 2002).

Mating disruption field trials

To determine the feasibility of mating disruption technology in turfgrass, this study conducted field trials with sprayable microencapsulated formulation of the OB sex pheromone. Two methods were used to determine the effect of treatments on the mating success of OB. The first method measured the ability of OB males to locate a pheromone source similar

Continued on page 64

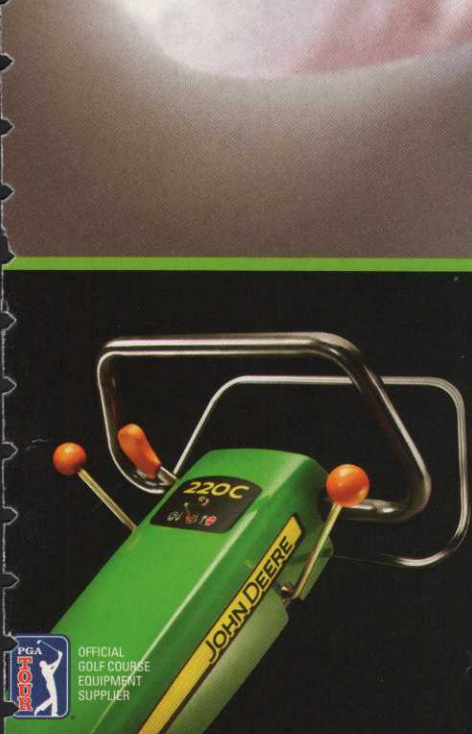


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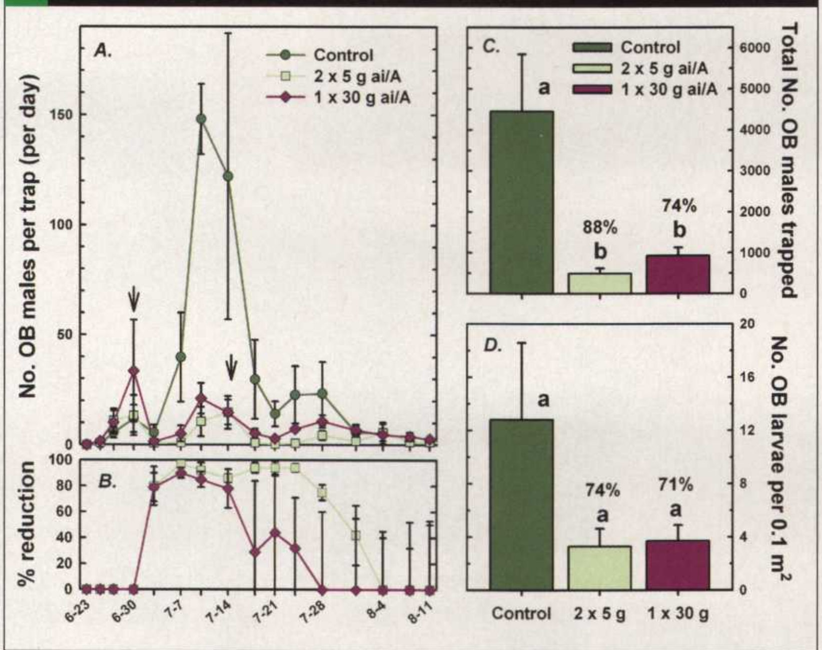
FIGURE 1



Field season 2003 A. orientalis mating disruption trial. A) Twice-weekly male trap captures (arrows indicate application dates). B) Percentage reduction in twice-weekly trap captures. C) Total seasonal trap captures. D) A. orientalis larval densities in September following application. Data with the same letter are not significantly different, and figures above bars indicate percent reduction compared to control.

Continued from page 62

to a female by determining the number of OB males captured in traps. Trapping was also used to monitor OB male flight and optimize application timing. Four (2002) or three (2003) traps lured with septa containing the pheromone were placed in each plot. Captured males were killed and counted.

The second method estimated OB larval densities during September following the applications by taking 30 soil/sod cores (4.25 inches in diameter by 4 inches deep) in a grid pattern at least 50 feet inside the plot. Plots measuring 0.8 acres to 1.4 acres were situated in large lawn areas and golf course rough areas in Monmouth County, N.J.

The treatment plots were broadcast sprayed with microencapsulated OB sex pheromone using locally available spray equipment. The first spray was applied about 10 days after the first OB males were captured in traps. Where applicable, a second spray was applied about 14 days after the first spray. In 2002, one treatment was applied consisting of two sprays of 20 grams actual ingredient per acre (g ai/acre) of a formulation developed by 3M Canada Co. (London, Ontario) containing 20 percent (Z)- and (E)-7-tetradecen-2-one at a 93:7 ratio.

In 2003, treatments consisted of one spray of 30 g ai/acre or two sprays of 5 g/acre.

Results

In 2002, OB male flight started in the first week of June and trap captures had two distinct peaks on 25 June and around 5 July (Fig. 1A). Percent reduction in trap captures (Fig. 1B) in the treated plots was 96 percent to 100 percent for the first week after each application but started to drop during the second week. Total trap captures were 87 percent fewer in the treated plots than in the control plots (Fig. 1C).

OB larval densities in September were 68 percent lower in the treated plots than in the controls. But due to high variation in the control plots, the reduction was not statistically significant in 2002 or 2003.

In 2003, OB male flight started in the last week of June, and trap captures peaked around July 10 to July 14 (Fig. 2A). Percent reduction in trap captures (Fig. 2B) in the treated plots was 96 to 100 percent for the first week after each application but started to drop during the second week. Total trap captures were lower in the single application at 30 g ai/acre treatment (74 percent reduction) than in the control, and were the lowest in the double application at 5 g ai/acre treatment (88 percent reduction) (Fig. 2C). OB larval densities in September were 71 percent to 74 percent lower in the treated plots than in the controls (Fig. 2D).

Adsorption of sex pheromone on shoes

OB pheromone can adsorb on surfaces it comes into contact, such as shoes. These can then attract male OB over an extended period of time.

To test whether shoes can be contaminated with enough OB pheromone to cause potential nuisance to their owners, one pair of athletic shoes was walked for 30 minutes through each of the areas treated with OB pheromone in the large field trials at one or eight days after treatment (DAT).

The shoes were lined up in a non-pheromone-treated turfgrass area, and OB males were collected from them for 45 minutes. No males were attracted to the control shoes. Significantly fewer males were attracted to shoes walked at eight DAT (average 1.8) than to shoes walked at one DAT (average 42.3).

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Conclusions

This study demonstrates the feasibility of mating disruption in turfgrass.

However, the effect of the pheromone spray started to wane after about 10 days, making a second application after 14 days necessary. White grub larval counts in the nontreated areas were too variable to allow for the detection of statistically significant difference. Nevertheless, the trend in the 2002 and 2003 field seasons was very consistent with 68 percent to 74 percent lower OB larval populations in the treated areas.

The efficacy of mating disruption using sprayable formulations could be improved with more frequent applications, probably even with lower pheromone application rates than used in this study. However, the availability of highly effective insecticides will limit the acceptance of mating disruption unless a formulation can be developed that is more effective and/or requires only one seasonal application. We don't believe that this goal can be achieved using microencapsulated sprayable formulations. The potential contamination of shoes and other clothing articles by the sprayable formulation also presents a liability to these formulations.

Dispersible pheromone formulations consisting of numerous broadcast small pheromone sources may solve the problems of limited persistence as well as contamination of clothing articles. Our ongoing studies with dispersible formulations look very promising and suggest that mating disruption can be an effective, safe, environmentally and economically sound, easily implementable, durable, and highly integrated pest management compatible option for OB management in turfgrass.

Albrecht Koppenhöfer is associate professor and extension specialist in turfgrass entomology at Rutgers University in New Jersey. His research and teaching emphasize the development of integrated pest management strategies for important turfgrass insect pests in the Northeast, in particular for the white grub complex and the annual bluegrass weevil. Collaborating with Koppenhöfer on the research and article were: Sridhar Polavarapu, professor and extension specialist in at Rutgers (deceased in 2004); Eugene M. Fuzy, senior laboratory technician in turfgrass entomology at Rutgers; Aijun Zhang, research chemist with the USDA-ARS Chemicals Affecting Insect Behavior Laboratory at Beltsville, Md.; Kristin Ketner, researcher with Suterra LLC in Bend, Ore.; and Thomas Larsen. Ph.D., director of product development at Suterra.

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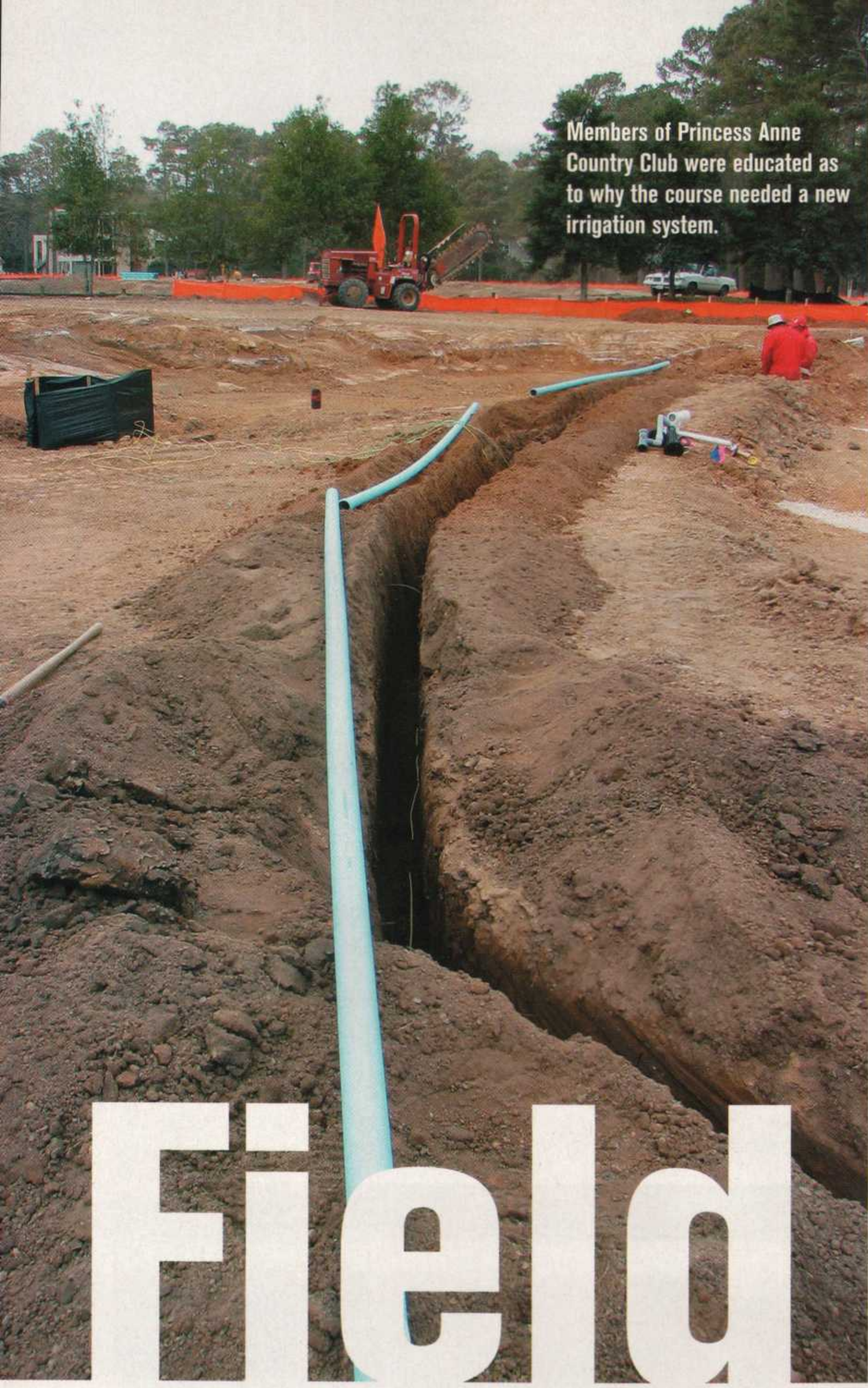

Members of Princess Anne Country Club were educated as to why the course needed a new irrigation system.

*Editor's note: This is part two of a two-part series on what it takes to achieve a successful golf course renovation. In this article discussing how superintendents address the challenges that come with course renovations, we look at the issue from owners' and general managers' perspectives. Here, club management discusses the importance of understanding the challenges faced by a club going through a renovation and the important role the superintendent plays in communicating it. The author, Lloyd von Scheliha, is a marketing manager for Rain Bird's golf division. Part one of the series, "Talk It Up," appeared in the August **Golfdom**.*

Field Generals

Superintendents are the eyes, ears and voices of a club during a renovation

BY LLOYD VON SCHELIHA

From the management's perspective, the superintendent should be a partner in a golf course renovation. Superintendents help management determine renovation needs; they convey the necessary renovation facts to course users; they help balance the many renovation considerations and act as the voice of the club on the project.

A golf course renovation offers significant challenges to club management no matter what type of facility is being renovated. In order to successfully traverse the renovation minefield, the course superintendent and club management must work together closely to maintain clear lines of communication during course renovation projects.

The superintendent plays a crucial role in equipping management with the informa-

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PHOTOS COURTESY: PRINCESS ANNE COUNTRY CLUB

Architect Tim Liddy hand grades along the eighth green.

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tion necessary to obtain approval for the project as well as keep the information flowing once the project is under way.

After Princess Anne Country Club opened a new clubhouse in March 2005 to replace the original historic building, the club's board of directors continued to carry out the strategic plan and sought an additional $4.5 million for a "renewal" of the course that was built in 1920 in Virginia Beach, Va.

"Our superintendent, Matt Boyce, was critical in this renewal project," says Bill Shonk, the club's general manager.

Shonk explains that Boyce served on the club's Golf Course Renewal Committee and was an active part of the presentations to the membership and neighborhood civic organizations with golf course architect Tim Liddy, USGA Green Section agronomist Stanley Zontek, McMahon Group consultant Frank Vain, and Renewal Committee chair Gary Beck. Boyce walked them through the issues facing the course, the value of the new grasses and the shortcomings of the course's existing irrigation system. He helped equip the club's members with the facts necessary for them to make the decision to proceed with the project.

Chico Lager had a similar experience with his club's superintendent at Burlington Country Club in Burlington, Vt. Lager, the club's greens committee chair, acted on behalf of management for the renovation project. Burlington's superintendent, Fred Martell, provided Lager with the facts and information he would need to address the questions and concerns of the board. The valuable input from Martell played an important role in justifying the project and selecting vendors.

The superintendent is also vital to help management balance the club's needs during a course renovation. Balancing the varying elements involved with a course renovation is far more complicated then a simple teeter-totter. It is more like trying to balance a piece of plywood on a golf ball.

Management considers how the project will affect play, member satisfaction, timelines, tournaments, position relative to peer courses, food and beverage sales and pro shop sales, to name a few things. Doing a renovation a section at a time can keep the course open but likely will extend the time horizon for the project.

Lager experienced this at Burlington. While the need for upgrading the irrigation system was not in dispute, Lager worked with his superintendent and irrigation distributor to justify the new system and rationalize the appropriate time frame to install it. As a result of these discussions, it was decided the course would remain open while the new system was

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