Turfgrass and Environmental Research Online

...Using Science to Benefit Golf

University of Wisconsin scientists investigated the use of various abrasives used as top-dressings, fungicides, and other treatments for their ability to reduce earthworm castings on in low-cut golf course turf. The results of their studies suggest that abrasive, angular aggregates may provide an alternative, legal, non-pesticidal management strategy for reducing earthworm castings to tolerable levels on low-cut golf course turf.

Volume 3, Number 23
December 1, 2004

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***.

Editor

Jeff Nus, Ph.D.
904 Highland Drive
Lawrence, KS 66044
jnus@usga.org
(785) 832-2300
(785) 832-9265 (fax)

Research Director

Michael P. Kenna, Ph.D.
P.O. Box 2227
Stillwater, OK 74076
mkenna@usga.org
(405) 743-3900
(405) 743-3910 (fax)

Managing Earthworm Castings in Golf Course Turf

R. Chris Williamson and Seung Hong

SUMMARY

In the spring of 2002 University of Wisconsin scientists initiated a comprehensive study to investigate the effectiveness of abrasive aggregates for potential suppression of earthworm casting production in low-cut golf course turf when applied as a topdressing amendment.

- Earthworms are beneficial to the soil, but on golf courses the castings they form are a nuisance.
- Because earthworms are beneficial organisms, no pesticide is registered or labeled for their control in the United States.
- Abrasive aggregates applied as topdressing reduce earthworm activity to tolerable levels, but their efficacy declines over time.

Earthworms are abundant, well-known inhabitants of the soil belonging to the order Oligochaeta. They are often referred to by a variety of names such as angleworms, fish worms, night crawlers, and dew worms. They are widely considered beneficial organisms due to certain favorable attributes such as soil formation, aeration and drainage, organic matter breakdown and incorporation, and even enhancement of microbial activity (3).

It is estimated that there are as many as 8,000 species from about 800 genera worldwide (3). They live in diverse locations, ranging from forests to lakes and streams, as well as grasslands, agroecosystems, including turfgrass (3, 4, 5). Earthworms are found in many regions of the world occurring in a wide variety of soil types, though they tend to be relatively scarce in primarily sandy soils.

Earthworms have two primary requirements: moist soil and an organic-matter food source, both of which are commonly plentiful on golf courses. In North America, it is estimated that there are 24 species of earthworms, however only three have been reported in turfgrass.

R. CHRIS WILLIAMSON, Ph.D., Turfgrass and Ornamental Entomologist; SEUNG HONG, Graduate Student; Department of Entomology, University of Wisconsin, Madison, WI.

Friend or Foe?

Despite the beneficial attributes of earthworms, they can be problematic due to the earthen casts that they produce on golf course turf, particularly in shaded, well-irrigated sites (1, 2, 6). Of the three earthworm species found in turf, only two species create soil castings. The night crawler, *Lumbricus terrestris* L., is the most common and abundant species of the two that construct earthen castings.

Earthworm casts are most common on low-cut turf including putting greens, approaches and collars, tee boxes, and fairways (6) (Figure 1). Earthworm casts disrupt the uniformity, appearance, and playability of affected areas (2). Soft wet castings are readily squashed flat by early

Figure 1. Despite the beneficial attributes of earthworms, they can be problematic due to the earthen casts they produce on golf course turf, particularly in shaded, well-irrigated sites.

USGA Turfgrass and Environmental Research Online 3(23):1-6.
TGIF Record Number: 100500

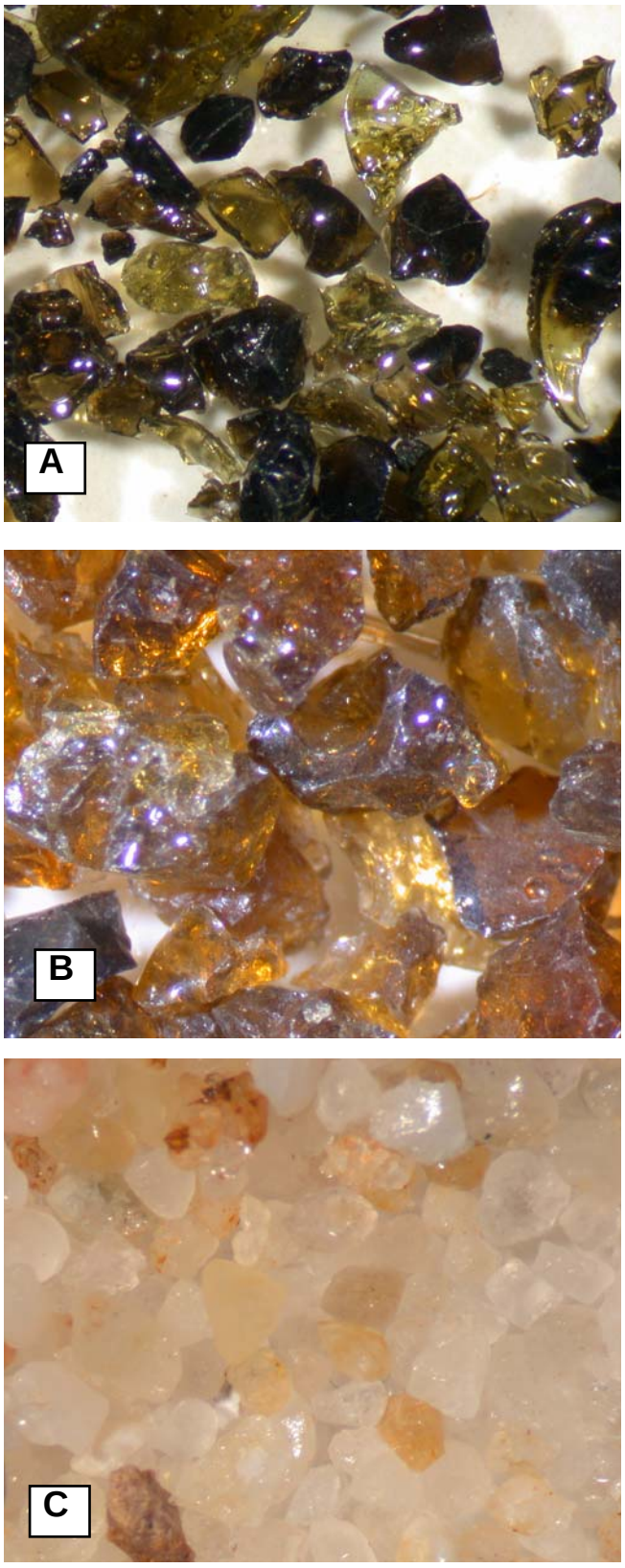

Figure 2. Experiments were initiated in 2003 and 2004 that included treatments of a coarser grade of Black Jack (A), another abrasive aggregate called Amber Jack (B), and Best Sand, an angular topdressing sand (C).

morning mowing operations, and closely mowed turf beneath the leveled casting is smothered. As a result, appearance and playability are negatively impacted in areas of the course where earthworm populations are dense. Furthermore, such impacted turf areas often experience turf damage or loss due to the inability of the plants to properly photosynthesize (4). Moreover, mechanical damage to mowing equipment including bed knives and reels may occur.

Because earthworms are considered beneficial organisms, no pesticides are registered or labeled for their control, and any pesticide application specifically intended to control earthworms is illegal in the United States. Therefore, alternative, nonchemical earthworm management strategies are needed.

Earthworms migrate up and down through the soil profile in response to changes in soil moisture content and soil temperature. Because the cuticle (skin) of earthworms is quite sensitive, sand and other abrasive substances likely irritate and repel them. The following research was aimed at exploiting this weakness.

Casting Suppression Studies

A three-year study was initiated in 2002 on two golf course fairways at Blackhawk Country Club (Madison, Wis.) where earthworms were problematic. The fairway was comprised of a mixture of creeping bentgrass (*Agrostis stolonifera*) and annual bluegrass (*Poa annua)* maintained at approximately 7/16 inch (11 millimeters). Respective treatments were applied to 10 x 10 feet plots (i.e., 100 ft^2) in a randomized design with four replications per treatment.

Several diverse earthworm casting suppression treatments were applied in 2002. Based on the promising results obtained from 2002 study, another similar experiment was initiated in 2003 and 2004 that included new treatments. These treatments included a coarser grade of Black Jack, another abrasive aggregate called Amber Jack, and Best Sand, an angular topdressing sand (Figure 2).

Black Jack, a byproduct of the coal indus-

try, is composed of the remains of coal after it is burned for production of electricity. Once the coal is burned, the resulting 1-2 inch (2.5-5-centimeter) colloids are crushed, fractionated into respective size ranges, demagnetized and kiln-dried. Black Jack is essentially inert, extremely hard, highly angular and predominantly black in color. Amber Jack, a byproduct of the paper mill industry, is comparable to Black Jack. It, too, is inert, highly angular and extremely hard, but it is considerably lighter in color, ranging from almost clear to reddish amber.

2002 Treatments

In spring 2002, an earthworm activity study was initiated that included the following treatments:

- untreated control
- thiophanate-methyl (Cleary's 3336) fungicide applied every 14-21 days
- carbaryl (Sevin) insecticide applied every 14-21 days
- soap, Joy dishwashing detergent applied every 7 days
- Hydroject, water-injection every 28 days
- Dragon spice (ground oriental mustard seed), one application
- zeolite, soil amendment, one 1/8-inch (3.2-millimeter) application
- Black Jack 20/40 crushed coal slag, one 1/8-inch (3.2-millimeter) application

2003-2004 Treatments

- untreated control
- thiophanate-methyl, fungicide applied every 21-28 days (1 gallon spray volume/1,000 ft^2)
- thiophanate-methyl, fungicide applied every 21-28 days (2 gallon spray volume/1,000 ft^2)
- Black Jack 20/40, spring application only
- Black Jack 20/40, fall application only
- Black Jack 20/40, spring and fall application
- Black Jack 30/60, spring application only
- Black Jack 30/60, fall application only
- Black Jack 30/60, spring and fall application
- Amber Jack, spring application only
- Amber Jack, fall application only
- Amber Jack, spring and fall application
- Best Sand, spring application only
- Best Sand, fall application only
- Best Sand, spring and fall application
- 2002 application of Black Jack 20/40

Results

Mean number of castings were calculated for each treatment during the growing season (April-November). Using pooled data, the use of abrasives (Black Jack 2040, Black Jack3060, Amber Jack 100, and Best Sand) significantly reduced number of castings per plot compared to untreated control plots (Figure 3). However, abrasives were not as effective in reducing castings per plot as fungicide treatments (Figure 4) or insecticides (data not shown). All other treatments had relatively little effect on earthworm activity.

The effects of spring versus fall applications and a combination of spring and fall application of abrasive topdressing abrasives were evaluated in the 2003 growing season (April - November). Turf quality, thatch accumulation and disease activity were also rated throughout the 2003 season to document any possible adverse effects that a thin layer of abrasive material might have in the upper rootzone of intensively managed golf course turf. Figure 5 shows the mean number of earthworm castings per plot for abrasives applied in the fall only, spring only, and spring and fall versus untreated control plots. Although results were variable between years, fall and spring treatments seem effective compared to untreated control plots.

Data also revealed that the effectiveness of the abrasives' abilities to reduce earthworm castings decrease measurably over time. We hypothesized that the aggregate's effectiveness had decreased because of its dispersion or its incorporation into the soil. These results support the idea that the aggregates eventually disperse into the soil, thus lose their effectiveness over time. As a result, additional applications of the aggregates are necessary to maximize their effectiveness.

When angular soil aggregates such as

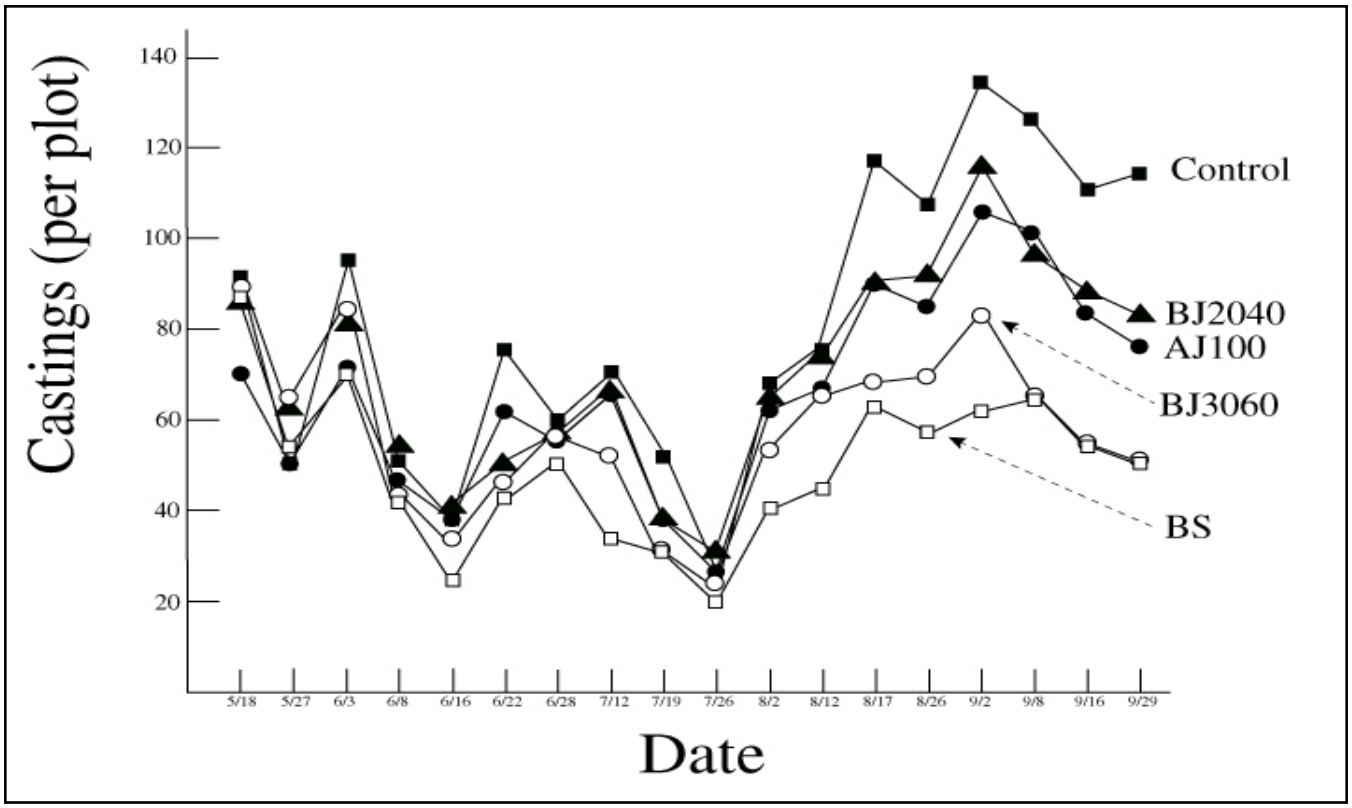

Figure 3. The use of angular, abrasive materials (Black Jack, Amber Jack, and Best Sand) resulted in fewer earthworm castings per plot when compared to untreated control plots. (2004 data)

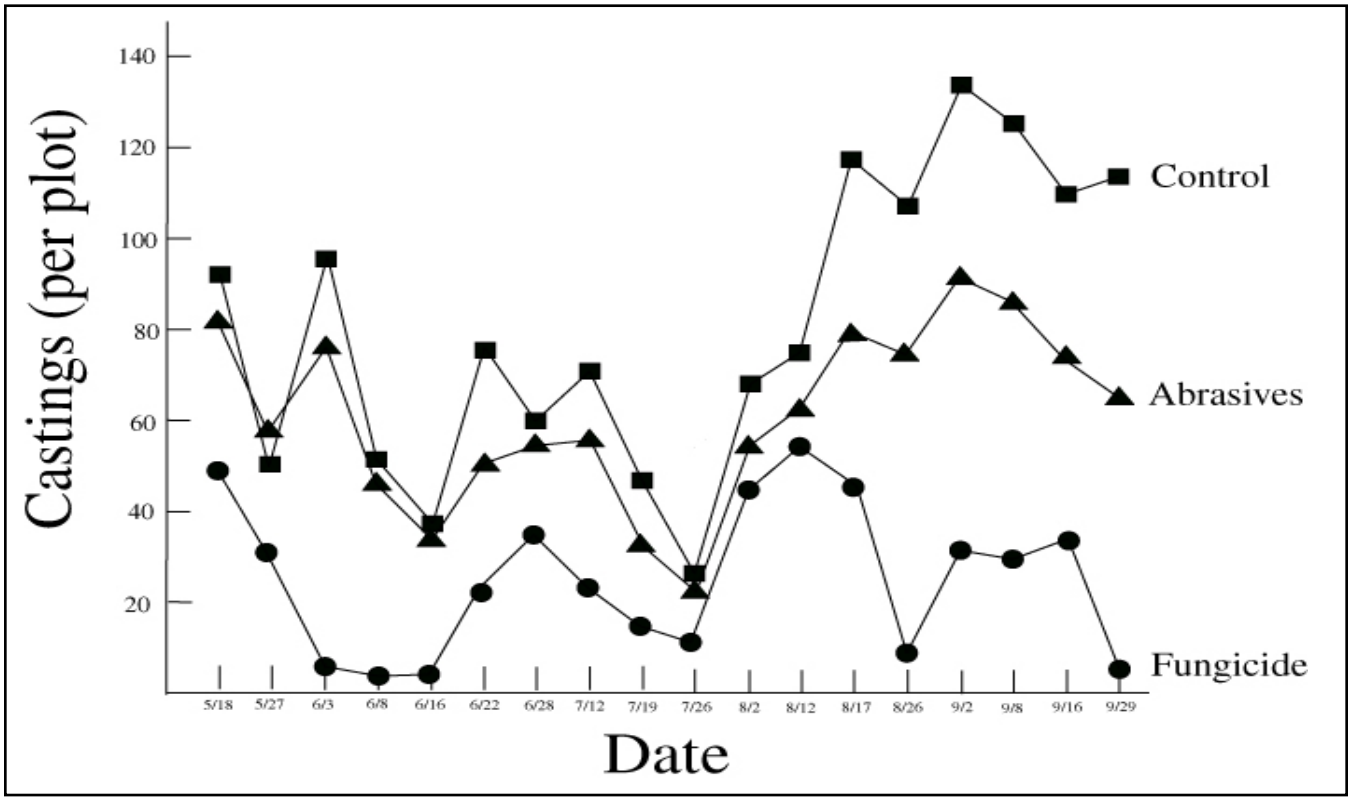

Figure 4. Although the use of abrasive topdressing materials to plots reduced the number of earthworm castings compared to untreated control plots, they were not as effective as fungicide (thiophanate methyl) and insecticide (carbaryl, data not shown) in reducing the number of earthworm castings per plot. (2004 data)

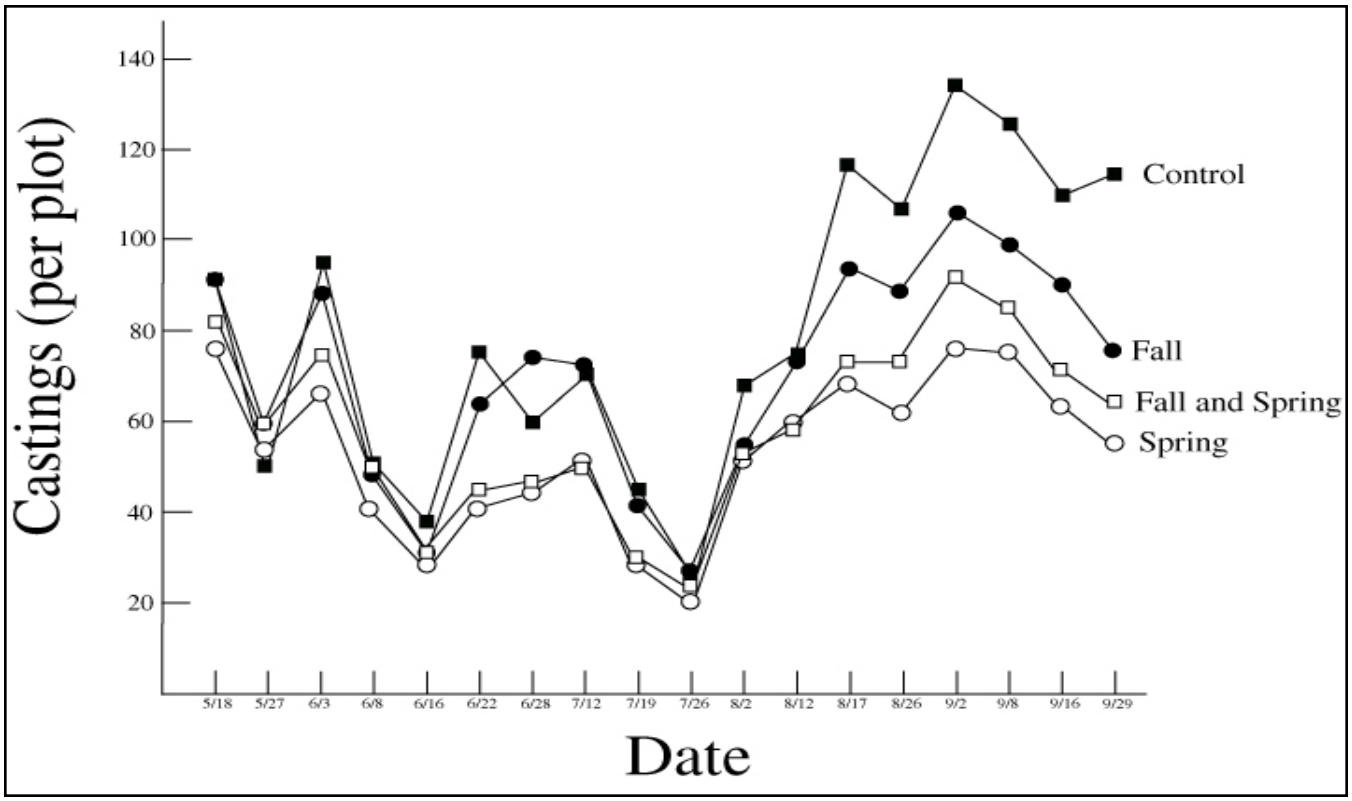

Figure 5. The results of timing study for abrasive applications were variable, however, due to the abrasives' dispersion or its incorporation into the soil, it is recommended that abrasives be applied both spring and fall to maintain suppression of earthworm castings.

Amber Jack, Best Sand, or Black Jack were applied in both spring and fall (combination), sustained suppression of earthworm castings occurred. No measurable differences the aforementioned aggregates occurred, or did particle size did have any meaningful effect.

As previously mentioned, the residual activity (effectiveness) of single season applications of soil aggregates appear to decline over time. Thus, multiple treatment applications is necessary. Since earthworm activity is most pronounced in the spring and again in the fall when ambient and soil temperatures are typically lower and soil moisture is greater, spring and fall topdressing applications of highly angular, abrasive aggregates may reduce earthworm populations to tolerable levels.

Potential for use of abrasive, angular aggregates for suppression of earthworm casts

The results of this study suggest that abrasive, angular aggregates such as Amber Jack, Best Sand, and Black Jack may provide an alternative, legal, non-pesticidal management strategy for reducing earthworm castings to tolerable levels on low-cut golf course turf. However, because the long-term attributes of abrasive, highly-angular soil aggregates are not understood, careful consideration should be administered before completely adopting this novel management strategy. When considering the use of such amendments, begin by treating only small areas of turf where earthworms are highly problematic to evaluate this management strategy before adopting for widespread use.

Acknowledgments

The authors thank the United States Golf Association as well as the Wisconsin Turfgrass Association for providing funding of this project. I thank Bob Vavrek (USGA Regional Agronomist) for his editorial and intellectual contributions. We would also like to thank 31-year GCSAA member Monroe S. Miller, golf course superintendent at

Blackhawk Country Club, Madison, Wis., for his cooperation and for providing the study site.

Literature Cited

1. Backman, P.A., E.D. Miltner, G.K. Stahnke, and T.W. Cook. 2001. Effects of cultural practices on earthworm castings on golf course fairways. *Int. Turfgrass Soc. Res. J.* 9:823-827. (TGIF Record 74333)

2. Beard, J.B. 1973. Turfgrass: science and culture. Prentice-Hall, Inc. Englewood Cliffs, NJ. (TGIF Record 294)

3. Edwards, C.A. 2004. Earthworm ecology. 2nd edition. CRC Press, Boca Raton, Fla. (TGIF Record 98808)

4. Kirby, E.C., and S.W. Baker. 1995. Earthworm populations, castings, and control in sports turf areas: A review. *J. Sports Turf Res. Inst.* 71: 84-98. (TGIF Record 34781)

5. Lee, K.E. 1985. Earthworms: Their ecology and relationships with soils and land use. Academic Press, New South Wales, Australia. (TGIF Record 81641)

6. Potter, D.A. 1998. Destructive turf insects: Biology, diagnosis, and control. Ann Arbor Press, Chelsea, MI. (TGIF Record 43046)