Earthworm Casting Creates Maintenance Nightmare

Good turf culture creates ideal conditions for earthworms. Thus, with few control strategies available, tolerance currently may be the best option for dealing with these highly adaptable creatures.

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Lumbricus terrestris, popularly known as the night crawler, is a primary producer of casting on golf courses.

Earthworm casting on the surface of golf course fairways rapidly is becoming one of the most challenging management issues for superintendents in the Pacific Northwest and other regions of the United States. I know firsthand that many superintendents are losing sleep over the earthworm-casting issue, and some fear losing their jobs as a result of their inability to control casting. Many golfers, club members, green committees and board members feel the superintendents aren't doing enough to combat the problem.

Casting occurs when earthworms ingest soil and leaf tissue to extract nutrients, then emerge from their burrows to deposit the fecal matter, or casts, as mounds of soil on the turf surface. Extensive earthworm casting on fairways interferes with proper maintenance practices, the playability of the turfgrass and the overall appearance of the fairways. Affected turf can become thin and the playing surface can soften.

Superintendents urgently need management strategies that discourage earthworm casting and population growth, while at the same time maintain soil quality. At Washington State University and Oregon State University, researchers are working to develop a program that golf-course superintendents can use to reduce casting. The aim is to find methods that will reduce initial earthworm populations to a threshold level where the amount of casting is tolerable and to prevent these populations from returning to excessive levels.

Why Is Earthworm Casting Occurring?

Earthworm populations can reach several million under golf course fairways, with millions more in the roughs going unnoticed due to higher mowing heights. Unfortunately for superintendents, the basic cultural practices that produce excellent fairway surfaces also create optimal living conditions for earthworms. Earthworms feed on fairway clippings returned after mowing and on organic matter in the soil. They love the consistent, moist, fertile conditions that typically are present in fairway turf. In other words, earthworm casting is not an indication of a superintendent's inability to grow healthy turf. In fact, the opposite is true.

Populations can reach damaging levels on golf courses for several reasons:

* Fairways often are planted on fine-textured soils that receive regular irrigation and nitrogen-fertilizer applications, which provide optimal growing conditions and a continuous food supply for earthworms.

* Earthworm activity is greatest when the soil moisture is near field capacity, which just happens to be the ideal moisture level for healthy turfgrass.

* The turfgrass canopy also helps provide favorable

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temperatures by insulating the soil from extreme weather conditions.

Earthworms cast on the surface for two primary reasons. First, after they ingest organic matter, decaying leaf tissue and mineral soil, they must excrete the leftover material. Second, earthworms live in relatively permanent burrows. When soil fills the burrows (often after heavy rains), earthworms ingest the soil and move it up to the surface to perform "house cleaning." Researchers working with earthworms have estimated that they may bring 20 to 25 tons of soil per acre to the surface each year.

"Who" Is Responsible for the Casting Problem?

More than 200 species of earthworms with varying behaviors and habitat preferences exist in North America. On Northwest golf courses, the primary species include *Lumbricus terrestris, Aporrectodea calignosa* and *A. longa.* Most species do not actually deposit casts on the surface. Many excrete material within the soil profile or not at all. Based on field observations, L. terrestris, familiarly known as the night crawler. Is the earthworm species causing severe casting damage on golf courses throughout the Pacific Northwest and in many other locations across the United States.

Night crawlers typically build permanent vertical burrows that vary in diameter from about 0.125 to 0.5 inch. In certain situations, these can extend up to 12 feet deep in the soil. However, due to regular irrigation and constant food supplies (clippings and other organic matter) on fairways, night crawlers tend to remain closer to the surface, migrating up and down in the soil with fluctuations in moisture content, soil temperature and atmospheric pressure. Peak earthworm activity and casting occurs during the cooler, wetter weather in the spring and late fall through early winter. Earthworms are generally intolerant of drought and frost conditions; they retreat to the bottom of their burrows during extremes in temperature and soil moisture, returning to the surface when conditions improve.

Night crawlers have long lives, with a reported average life span of six to nine years (up to 20). They breed, on average, once every two weeks, producing up to 20 offspring with each cycle. Breeding activity is greatest in the cool, moist conditions of spring and late fall, which also results in increased casting activity as they surface to find a mate. Researchers report that one mature night crawler can produce several hundred offspring in one year. The young night crawlers can grow several inches per year and are sexually mature after the first year. Because fairways provide optimal living conditions, unlimited space and a constant food supply, it is easy to see how earthworm populations and casting can get out of control.

Control Options for Managing Casts

Currently, no pesticides are registered for controlling earthworms in the United States, which severely limits the ability of superintendents to manage this highly destructive problem.

At Washington State University, Puyallup, Wash., and Oregon State University, we initiated a series of short- and long-term field studies in the spring of 1998 designed to reevaluate several cultural practices that other research has shown to be detrimental to earthworm activity in other regions of the world. These studies are evaluating soil-chemistry effects, the effects of clipping removal (alone and in combination with spring, and spring + fall, aerification), and sand topdressing at a rate of 0.625 inch of sand per year (alone and in combination with fertilizer treatments) to determine if sand effectively reduces casting.

Several environmental and cultural factors affect earthworm activity, populations, soil distribution and species. The most critical include an adequate food supply, moisture, temperature, soil texture and pH. Researchers have shown that certain cultural factors alter these critical properties so they are less conducive to earthworm activity.

1. **pH.** Many researchers have reported declines in earthworm populations directly related to declining soil pH (increasing acidity). Consistent with this is the fact that earthworms are scarce in soils with a pH of 5.0 or less, and plentiful between 6.5 and 7.0. Thus, ammonium-sulfate fer-

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tilizers may be beneficial in this regard by increasing acidity. Similarly, you should avoid using excessive lime.

In the Pacific Northwest, one researcher reported no earthworm activity on plots of creeping bentgrass treated with sulfur. However, it is possible that, instead of population reduction, acidity merely shifts species composition to non-casting earthworms that are more tolerant of acid conditions.

2. **Food.** Earthworms feed on organic matter in the soil and decaying clippings returned to fairways after mowing, which provide a practically unlimited food supply. In turf, they often pull leaf clippings down into the mouth of the burrow, where the tissue softens for later consumption. The amount of food in the soil and on the surface can influence earthworm populations. One researcher found that nightcrawlers do not burrow deep into the soil profile if adequate food is available near the surface. Other investigators have reported that rates of casting were reduced when clippings were removed. Thus, it is possible that collecting clippings could reduce earthworm populations.

3. **Soil texture.** Earthworm populations are highest in light- and medium-textured loam soils. Smaller populations occur in both heavy, poorly drained clay soils and coarse, abrasive, sandy soils. Researchers believe that the susceptibility of such soils to drought and the abrasiveness of sand particles can influence both species composition and overall earthworm numbers in the soil.

One researcher has observed that earthworm populations are low in soils that are compacted, puddled, overgrazed or contain heavy clays. Fairways often are established on heavy soils that are more prone to compaction, which forces *Lumbricus terrestris* to expel the majority of their castings on the surface instead of in the voids within the soil. This probably is one reason we often see more casting in the clean-up areas on the edges of the fairways.

In my own research, after a full year of evaluating soil acidity, clipping removal and sand topdressing, I have not observed a significant reduction in earthworm casting due to variations in these factors. Some authors have reported that the response to various soil factors is not the same for all earthworm species. From my observations, *Lumbricus terrestris* is a highly adaptable survivor able to persist in a wide range of soil conditions. Thus, I feel it is probable that the species of earthworms present in many of the research projects I mentioned above were not L. *terrestris*. In addition, most of the above studies required several years of treatment applications before the earthworm reductions were evident, and in most cases the reductions reported typically were only in the range of 20 to 50 percent.

New Strategies for Reducing Earthworm Populations

To explore novel methods of reducing earthworm populations, we are working with several earthworm-harvesting companies in Washington and Oregon. A large demand exists around the world for the type of earthworm located under golf course fairways, primarily for use as fishing bait. This demand makes earthworms a fairly valuable commodity. Currently, harvesting the worms involves bringing them to the surface by applying an irritant to the site and handpicking the earthworms when they emerge from their burrows. Obviously, this process is very labor intensive. Thus, we also are attempting to develop efficient methods for superintendents to bring the worms to the surface and remove them by mechanical or handpicked methods. We have currently assessed a core harvester, several turf vacuums and triplex brush units, but with limited success so far.

In evaluating the short- and long-term effects of physical removal, we have found that it significantly reduces casting in the short term, but it does not completely eliminate casts. A methodical, long-term approach of repeated harvests is necessary to continue to see measurable reductions. For example, an 18-hole country club in western Oregon hired a company to harvest all of their fairways in the spring of 1998. The final removal count over a 4-week period was 2.1 million worms. A second complete harvest in the fall produced about 750,000 additional worms. Although this seems like a lot of worms, this site still needs additional harvests to reduce casting to an acceptable level.

Tolerance and Education

The issue of earthworm casting is one that surfaces over and over again (no pun intended) in pro shops, clubhouses and board and green committee meetings. Unfortunately, the issue is usually addressed without a complete understanding of the problem. At the heart of the issue is the quality of turf and how casting affects the type of lie a golfer has on the fairways. Fairway casting, when severe, can affect the implementation of summer and winter rules, with earlier winter rules initiated in the fall and a later start on summer rules in thespring. The golfers and club members who prefer to "play the ball down" year round tend to be the most vocal about

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earthworm casting.

For the record, I am an avid golfer. I understand the frustrations associated with soft fairways and thin turf caused by the soil deposits of casting. In addition, as an assistant superintendent at Everett Golf and Country Club in western Washington, I experienced firsthand the challenges of managing earthworm casting.

However, after studying earthworms for the last year and a half, I have gained a great deal of respect for their ability to adapt, survive and persist, even in less-than-optimal environments. Thus, earthworm casting is an issue that inevitably will require some tolerance on the part of golfers. It is unfortunate and unfair that there are superintendents around the country that face so much pressure over earthworm casting that they fear losing their jobs. After all, earthworms prefer the same conditions required to maintain healthy turfgrass.

I cannot over-emphasize that no products or pesticides are specifically labeled to control earthworms. This severely limits the ability of superintendents to manage this problem. Also, in most (not all) regions of the United States that experience heavy earthworm casting, the most severe casting tends to occur in late fall and winter when the recuperative ability of the turf is minimal. Fortunately, the number of rounds during these months typically is lower.

We must remember that earthworms provide far more benefit than harm to the soil/turf environment. The earthworm's burrowing and feeding activity initiates thatch decomposition, stimulates microbial activity, makes certain plant nutrients more available, increases soil aeration and, in general, improves overall soil quality.

Our research project will continue until we are able to develop an Integrated Management System for reducing casting. This is not an easy task. With time, we should have a better picture of how soil acidity, clipping removal, sand topdressing and other strategies affect earthworm casting after multiple years of treatment applications. We also will continue to look at new, untested strategies for earthworm-casting reduction. In the meantime, we must accept that few chemical options exist for earthworm control, and cultural strategies are not well understood. Golfer education and tolerance of casting are necessary for the time being.

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(Editor's Note: Paul Backman is a research associate in turf management at Washington State University, Puyallup, Wash. This article was reprinted with permission from Grounds Maintenance magazine.)