Controlling Earthworm Casts on Golf Courses

A natural byproduct shows promise.

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Dry and muddy compacted earthworm castings on a push-up putting green.

Excessive earthworm casts are a worldwide problem on golf courses and sport fields when they disrupt the playability, aesthetics, and maintenance of playing surfaces (3, 6, 11). Casting occurs when worms deposit their soil-rich fecal matter as small mounds, called casts, on the surface. They adversely affect ball roll and muddy and smother the grass when smeared or compacted by tires or foot traffic. In 2009 the Sports Turf Research Institute rated earthworms the number-one problem about which they receive queries.

Earthworm tunnels lessen soil compaction and provide passageways through which air and water can percolate, enhancing penetration and growth of plant roots. In addition, earthworm feeding activity stimulates microbial decomposition of grass clippings and thatch and accelerates nutrient recycling (10), so a moderate level of earthworm activity is beneficial even on golf fairways.

During the past 20 years, however, the problem of excessive earthworm castings interfering with play on golf courses has become more serious and widespread. Why? Residues of old, highly persistent chemicals like chlordane, banned many years, are finally dissipating from soils and no longer suppressing earthworms. Earthworm-toxic soil insecticides, like diazinon, bendiocarb, and carbaryl, have been replaced by chemistries that are more selective.

This article describes a promising new approach to managing excessive earthworm casts on golf courses using tea seed meal, a byproduct of tea oil manufacturing that contains natural surfactants called saponins.

HISTORY OF EARTHWORM MANAGEMENT

Early turf culture evolved in rainy Great Britain, where earthworms are very abundant. Rolling was the main management practice before 1890, but it was eventually recognized as having negative effects (e.g., soil compaction). Two other main approaches evolved, one based on cultural control and the other on chemical control that uses pesticides or expellants (6).

Cultural controls, including use of soil-acidifying fertilizers, clipping removal to reduce earthworms' food sources, or topdressing with angular sands or abrasive aggregates sometimes reduce casting (1, 2, 14). However, an extensive study done on golf course fairways in Washington State (1) indicated that clipping removal, soil acidity, and sand topdressing had no consistent effects on castings deposited on the turfgrass surface by earthworms.

Pesticides historically used to control earthworms included mercuric chloride, lead arsenate, and even sodium cyanide — all long since banned (6). During the 1950s and 1960s, a single application of chlordane would kill earthworms and

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Treated (background) and non-treated (foreground) plots on a pushup green showing reduced numbers of worm casts following treatment with TSP at 6 lbs. per 1000 square feet.

eliminate casting problems for as long as seven years. However, the EPA cancelled chlordane registration for turfgrass between 1978 and 1983 because of its buildup in the environment, harm to wildlife, and chronic human health risks.

Many of the turfgrass pesticides used from the 1970s to mid 1990s were acutely toxic to earthworms and suppressed them when applied for grub control (12). Most of the older worm-toxic pesticides have been cancelled, although two that remain are still sometimes used off-label to suppress worms and casting. There presently are no pesticides labeled for earthworm control in the United States.

PETER LEES´ INVENTION

Another widely used approach used for earthworm and cast suppression from early in the 20th century until about 1960 involved the use of chemical expellants (6). The method, pioneered by British greenkeeper Peter W. Lees during the 1890s, was so effective that it had become the mainstay for earthworm suppression on European and United States golf courses by the 1920s (4, 5, 7, 8, 9).

Lees' method involved applying powdered mowrah meal, a meal made from seeds of *Bassia latifolia*, the butter tree of India, after the edible oil had been pressed out. Natural components in mowrah meal irritated the earthworms, causing them to come to the surface, where they were raked into piles, shoveled into wheelbarrows, and hauled off the site.

Lees' method is regarded as among the most important historical innovations in turf management, in part because it allowed expansion of British golf courses on upland soils previously ill-suited for golf because of the unplayable putting green surfaces caused by earthworms (11). At one time, at least a dozen proprietary fertilizers and other products containing mowrah meal were marketed for earthworm control on golf courses (9). The use of the method declined in the late 1940s and 1950s with development of chlordane and other earthworm-toxic synthetic pesticides.

Mowrah meal is rich in saponins, natural soaps or surfactants found in the leaves and seeds of oats, spinach, alfalfa, chickpeas, soybeans, ginseng, tea, and hundreds of other plants (8). Although saponins were never confirmed as the earthworm-active component in mowrah meal, it is highly likely that their detergent-like irritation of earthworms' mucus membranes was the basis for its effectiveness. Mowrah meal is no longer marketed for earthworm management.

The first author on this article attended a sports turf conference in Beijing, China, in 2007, where he learned of another natural substance used there to suppress earthworms and casting on sport fields. The method involves applying a byproduct of tea oil manufacture. Tea seed oil, pressed from seeds of the Chinese tea oil plant, is used for cooking in eastern Asia, and in soaps and shampoos, margarine, ointments, and other products. Although tea oil websites claim efficacy for earthworm control, a 2007 search of the worldwide scientific literature found no references or data supporting that claim.

TESTING TEA SEED MEAL IN THE U.S.

We started researching tea seed meal in autumn 2007 to determine if it could be used to reduce earthworm casts on playing surfaces. Most of the early trials were done on a large, predominantly Penncross creeping bentgrass push-up green at the University of Kentucky's A. J. Powell, Jr., Turfgrass Research Center, near Lexington.

Crude tea seed pellets (left) and Early Bird fertilizer (right). Note the fine granule of the fertilizer product.

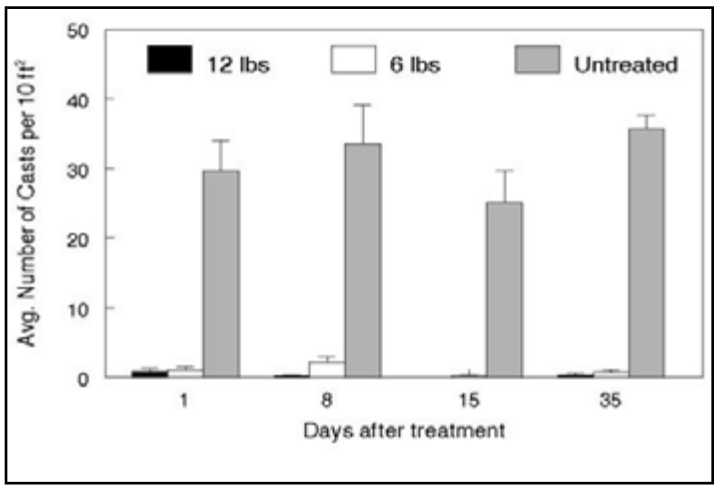

Figure 1. Reduction in earthworm casts on a creeping bentgrass push-up green after applying crude tea seed meal at 6 or 12 lbs. product per 1,000 square feet in April 2008.

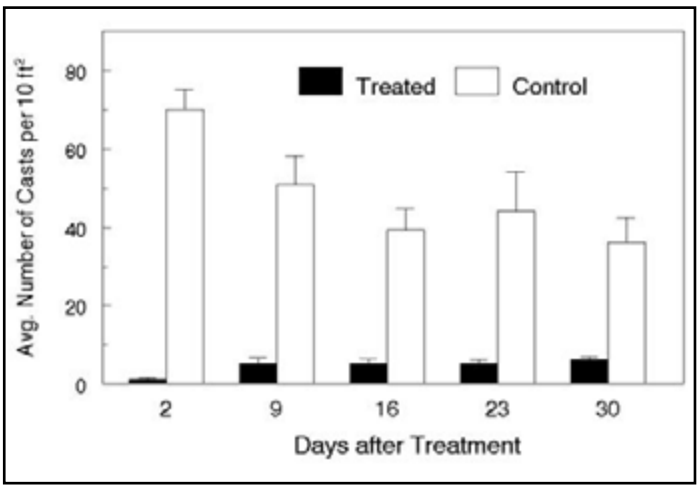

Figure 2. Reduction in earthworm casts following application of crude tea seed meal (6 lbs. product per 1,000 square feet) on a perennial ryegrass golf fairway in October 2008.

Other trials were done in fairway-height creeping bentgrass and on a perennial ryegrass golf fairway (14).

Our initial tests were with crude tea seed meal pellets (3.2 mm diameter, 5-8 mm long) and powder obtained from a source in China. The latter, essentially a dust, proved awkward to apply, so later work focused on the pellets. Application of tea seed meal at 6 lbs. of material per 1000 square feet, followed by irrigation, quickly expelled as many as 200 worms per 10 square feet on the push-up green. Most of the expelled worms dried up and died on the turf surface.

A single tea seed meal application in early April 2008 reduced castings in replicated plots on the push-up green by more than 95% for at least five weeks (Figure 1). In another trial on the push-up green, application of tea seed meal in early October reduced casts by 98% after two days, and 83% after 30 days (Figure 2). Finally, a sequence of lab trials confirmed that the chemical basis for tea seed meal's activity on earthworms is the natural triterpene saponins found in tea seeds.

EARLY BIRD™ NATURAL ORGANIC FERTILIZER

Representatives of Ocean Organics Corporation (Ann Arbor, Michigan / Waldoboro, Maine), developer and manufacturer of natural fertilizers and bio-rational materials for turf, ornamental horticulture, and specialty agriculture, expressed interest in developing a tea seed meal-based organic fertilizer. They formulated the raw meal into a finer, proprietary blend of tea seed meal, kelp extract, and composted poultry manure, called Early Bird™ 3-0-1 Natural Organic Fertilizer, suited for golf course use. Early Bird™ is not labeled for earthworm control, although registration as a biological pesticide is being pursued.

Although saponins in tea seed meal have low acute oral and dermal toxicity for vertebrates, including mammals and birds (13), high concentrations of saponins are toxic to fish. However, with sensible guidelines (e.g., buffer zones around ponds and streams, and not treating saturated soils where run-off could occur), it should be possible to use a tea seed meal-based product without harming aquatic organisms.

A potential issue with earthworm expellants such as tea seed meal or mowrah meal is the unsightly nuisance and temporary odor when large numbers of worms die on the surface. In our experience, the expelled worms dry up relatively quickly and most of them are removed by mowing.

CONCLUSIONS

This research indicates that tea seed meal, a natural byproduct of tea oil manufacture containing natural surfactants called saponins, is effective for expelling earthworms and suppressing casting on playing surfaces. The mode of action is similar to that of mowrah meal, a mainstay for managing earthworms on golf courses a century ago. Tea seed meal has been formulated into an organic fertilizer (Early Bird™ 3-0-1) suitable for use on fairways and putting greens by Ocean Organics Corporation.

Most of the casting problems on North American golf courses are caused by non-native, invasive earthworm species. Saponin-rich natural products such as tea seed meal have promise as an alternative to off-label use of synthetic pesticides for alleviating the problems caused by excessive earthworm casts on low-cut playing surfaces.

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Worms expelled by TSM from 1 square meter on a push-up green.

Worms surfacing after application of TSM on a golf fairway in Connecticut.

Dried-up earthworm a few hours after treatment.

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