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Using organic products to reduce earthworm castings

No products are labeled for earthworm control in the U.S. or Canada, but some organics applied for other purposes may be effective.

Earthworm castings (which consist of a mix of earthworm fecal matter and soil) disrupt aesthetics, management and playing conditions on golf courses around the world (4,6,11-13). In 2009, the Sports Turf Research Institute received more questions regarding earthworms than any other topic (12).

Castings are typically a problem in cool, humid regions with fine (high in silt and clay) soil that has a neutral or alkaline soil pH. In North America, earthworm castings are particularly a concern in the transition zone, the Pacific Northwest and Canada. Earthworm activity is most prevalent during periods of frequent rainfall and moderate temperatures. The coastal regions of Northern California, Oregon, Washington and British Columbia, where earthworm activity is profuse (5), typically receive 40 to 60 inches (~100 to 150 cm) of rainfall from October through April, and winter temperatures normally do not dip to freezing (the January average temperature in Corvallis, Ore. is 45 F [7 C]).

Castings removal

Reel mowers with rollers flatten castings. The resulting “mud pancakes” smother the turf and cause an unsightly playing surface that disrupts ball lie and roll. In the Pacific Northwest, it is not uncommon for native soil fairways or tees to be riddled with thousands of dead spots, 1 to 2 inches (2 to 5 cm) in diameter, where turf was mowed before castings removal. Tees do not suffer as much damage as fairways, because the golf ball is placed on a tee, not on the ground, and the ball does not bounce on the surface of the tee as it does on a fairway. Earthworm castings also dull mower blades and stick to rollers.

When time and budgets permit, brooms or drag mats are often used to remove castings before maintenance, but adding this step to the morning maintenance program not only



Earthworms (*Lumbricus terrestris*) (top) and casting (bottom) in Corvallis, Ore. Photos by Tom Cook

increases labor costs, but also delays morning play (6). Other integrated pest management practices used to mitigate earthworm castings include acidifying fertilizer, clipping removal and sand topdressing (5). Research has determined, though, that in environmental conditions conducive to earthworm activity, cultural practices have little or no effect on earthworms (1). Field observations have shown that heavy sand topdressing is effective after the layer of sand reaches 3 to 4 inches (7.6 to 10.16 cm) deep. The hypothesis is that earthworms do not like to digest large amounts of angular sand, which may also explain why earthworm castings are not a problem on sand-based putting greens. Few golf courses have the budget to apply this amount of sand to fairways, however.

Although earthworms may be disruptive to fairways, they are still beneficial to the golf course as a whole (1,10). Earthworm tunneling improves infiltration and gas exchange within the soil, and relieves soil compaction. Earthworms also consume organic matter, mitigating thatch accumulation. Therefore, earthworms provide several benefits in areas that receive minimal maintenance, such as the golf course rough.

Earthworm control

Over the past 40 years, pesticide restrictions in the United States and Canada have compromised the golf course superintendent's ability to manage earthworms with pesticides (6,14). Currently, no pesticides are registered for control of earthworms in the two countries.

Before the 1940s, when pesticides were not available for control of earthworms, Peter Lees' method of using a chemical expellant was the accepted earthworm control technique (2,3,6-9). This method uses natural soaps and soil surfactants to irritate earthworms in the soil, causing them to attempt to escape the irritant by moving to the soil surface, where they can be removed. Saponins are a natural soap or surfactant found in mowrah meal, the plant byproduct used by Lees for expelling earthworms. Although mowrah meal is no longer commercially available, other natural soaps and surfactants are. For instance, some researchers observed a substantial reduction in earthworm casting activity when using crude tea seed meal on putting greens



and fairways (12,13). After this research was conducted, a crude tea seed meal product, Early Bird (Ocean Organics, Waldoboro, Maine), became commercially available. Recent research (15) determined that ring-billed gulls (*Larus delawarensis*) were not affected by earthworms treated with tea-seed cake pellets. The availability of published research on organically derived products and their effects on earthworm castings production is minimal, however. The objective of this project was to evaluate the effects of commercially available organic fertilizers and biologically derived products on earthworm casting activity.

Materials and methods

Research was initiated on Oct. 13, 2014 and concluded April 14, 2015 at Trysting Tree Golf Course in Corvallis, Ore., and was conducted on a mixture of colonial and creeping bentgrass mowed at 0.5 inch (1.27 cm). No fertilization or irrigation was applied during the trial. The golf course has a naturally high population of night crawler earthworms (*Lumbricus terrestris*), which create worm castings.

Four naturally derived products labeled for use on turfgrass were tested in this research: Turf Tour TAG, Turf Tour Defend, Sincocin and Early Bird Liquid. Turf Tour TAG (E. Marker A/S, Padborg, Denmark) is an organic fertilizer (1.4% N - 0.7% P₂O₅ - 0.4% K₂O) and soil conditioner with soil penetrant properties. TAG applica-

Earthworm castings after being mowed (right) on a golf course fairway in Corvallis, Ore., in February 2016. Photos by Brian McDonald

Effects on earthworm castings

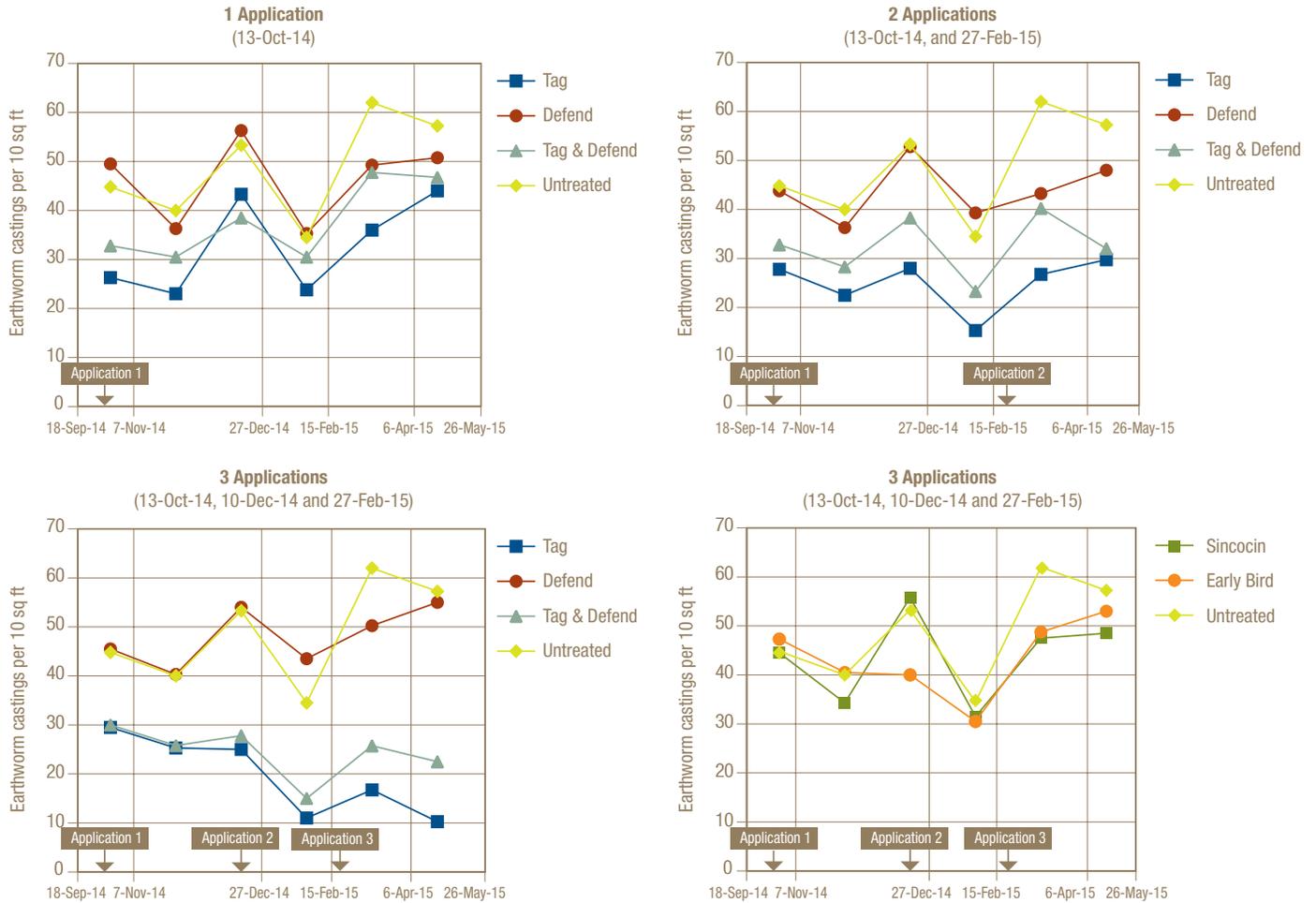
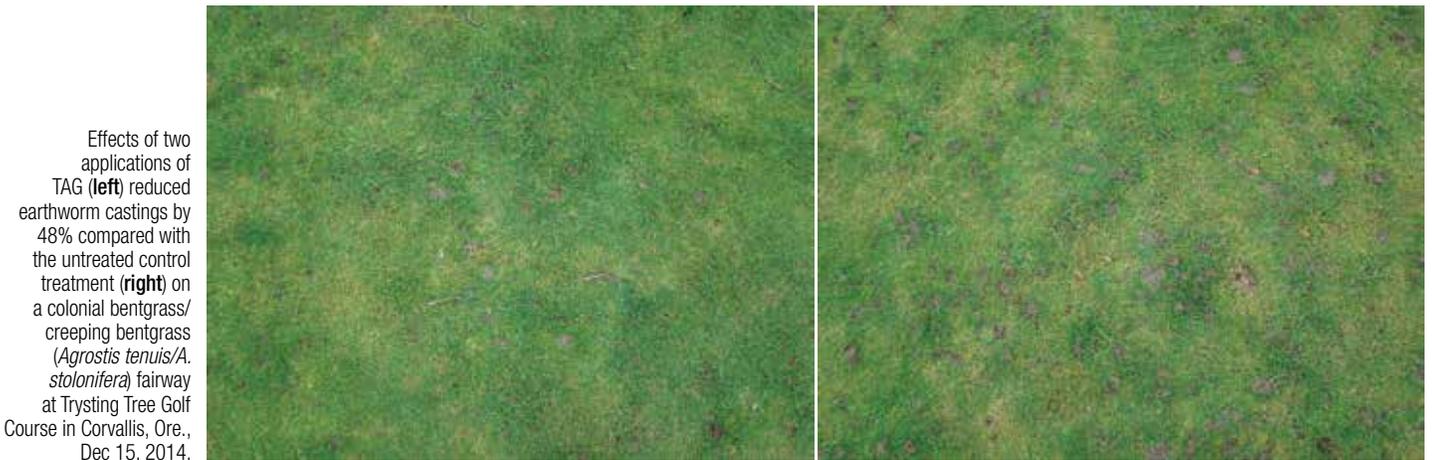


Figure 1. Effects of TAG, Defend, TAG + Defend, Sincocin and Early Bird Liquid on earthworm casting within a colonial bentgrass/creeping bentgrass (*Agrostis tenuis/A. stolonifera*) fairway at Trysting Tree Golf Course in Corvallis Ore., in 2014 and 2015. Application rates were: TAG at 6 pounds product/1,000 square feet for applications 1 and 2, and 7.2 pounds product/1,000 square feet for application 3; Defend at 3.1 fluid ounces of product/1,000 square feet; Sincocin at 3 fluid ounces of product/1,000 square feet; Early Bird Liquid at 6 fluid ounces of product/1,000 square feet for applications 1 and 2, and then 18 fluid ounces of product/1,000 square feet for application 3. For TAG, Defend and TAG + Defend, a single application was made on Oct. 13, 2014. For the two-application experiment, applications were made on Oct. 13, 2014 and Feb. 27, 2015. For the three-application experiments with TAG, Defend and TAG + Defend, and Sincocin and Early Bird Liquid, applications were made on Oct. 13, 2014, Dec. 10, 2014 and Feb. 27, 2015. Arrows denote the application dates.





Effects of three applications of TAG (**left**) reduced earthworm castings by 82% compared with the untreated control treatment (**right**) on a colonial bentgrass/creeping bentgrass (*Agrostis tenuis/A. stolonifera*) fairway at Trysting Tree Golf Course in Corvallis, Ore., April 14, 2014.

tion rate used in this research was 6 pounds product/1,000 square feet (29.29 ml/square meter) for the first and second applications, and then 7.2 pounds product/1,000 square feet (32.15 ml/square meter) for the third application. Granular applications of TAG were made with a shaker can.

Similar to TAG, Early Bird Liquid (Ocean Organics, Waldoboro, Maine) is an organic fertilizer (3% N - 0% P₂O₅ - 1% K₂O) derived from oilseed meal, kelp extract and composted poultry litter. The Early Bird Liquid rates used in this research were 6 fluid ounces of product/1,000 square feet (1.9 ml/square meter) for the first two applications, and then 18 fluid ounces of product/1,000 square feet (5.7 ml/square meter) for the final application. Early Bird Liquid was applied with a CO₂-pressurized bicycle sprayer with TeeJet XR 80015 nozzles at 2 gallons/1,000 square feet at 30 psi (81.49 ml/square meter at 206.8 kPa).

Turf Tour Defend (E. Marker A/S, Padborg, Denmark) is a plant biostimulant derived from essential plant oils (garlic, pepper and nettle). The application rate for Defend used in this research was 3 fluid ounces of product/1,000 square feet (0.95 ml/square meter). Similar to Defend, Sincocin (Agriculture Sciences Inc., Dallas) is a biologically derived agent registered for control of nematodes and associated pathogens. The application rate for Sincocin in this project was 3 fluid ounces of product/1,000 square feet. Liquid applications of Defend and Sincocin were also made with a CO₂-pressurized bicycle sprayer with AI8002 air-induction TeeJet nozzles at 35 psi (241.31 kPa) and a spray volume of 2 gallons/1,000 square feet.

Treatments included one, two or three sequential applications of Turf Tour TAG, Turf Tour Defend, and TAG + Defend, as well as three sequential applications of Sincocin and Early Bird Liquid. All were compared with an untreated control plot or control.

Earlier work has shown that the effectiveness of these products is greatest when they are watered in, and throughout our research process, treatments that were not irrigated in were not effective (data not shown). The treatments were therefore made before rain events given that golf course irrigation systems in the Pacific Northwest are shut down from October to April because rainfall is extensive and, occasionally, freezing temperatures damage active irrigation systems. Considering this, for plots that received one treatment, applications were made on Oct. 13, 2014. Plots that received two sequential treatments received applications on Oct. 13, 2014 and Dec. 10, 2014. Finally, plots that received three sequential treatments received applications on Oct. 13, 2014, Dec. 10, 2014, and Feb. 27, 2015.

The trial was arranged in a randomized complete block design with four replications. Each plot measured 5 feet (1.5 meters) wide by 8 feet (2.4 meters) long (40 square meters [3.7 square meters]). Data includes visual earthworm castings counts/10 square feet, and turf quality (1 to 9 scale) assessed from Oct. 13, 2014 to April 14, 2015.

Results

Earthworm castings

One, two and three applications of TAG reduced earthworm casting counts in comparison with the control (Figure 1). There

Turfgrass quality

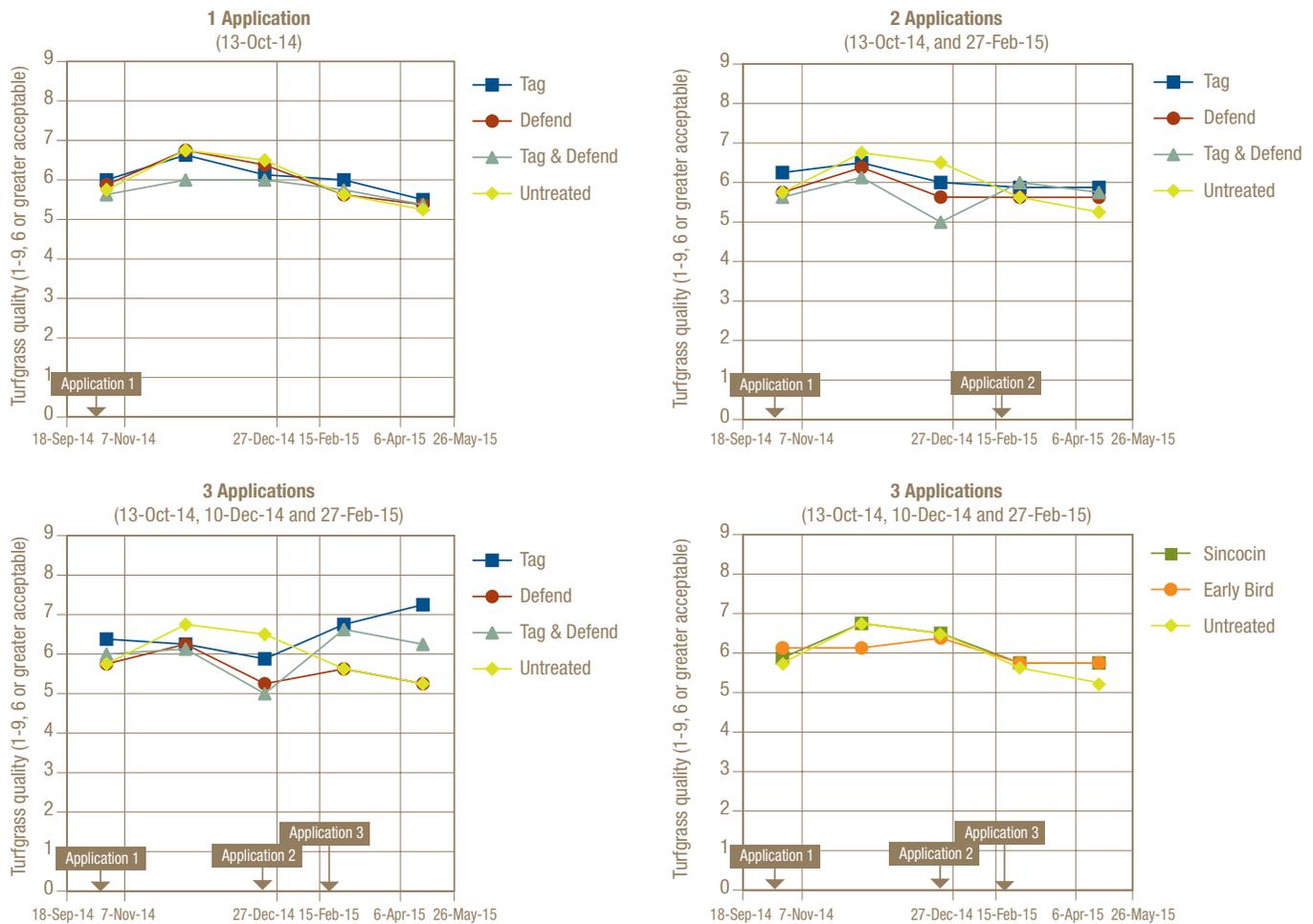


Figure 2. Effects of TAG, Defend, TAG + Defend, Sincocin and Early Bird Liquid on turfgrass quality within a colonial bentgrass/creeping bentgrass (*Agrostis tenuis/A. stolonifera*) fairway at Trysting Tree Golf Course in Corvallis Ore., in 2014 and 2015. Application rates were as follows: TAG at 6 pounds product/1,000 square feet for applications 1 and 2, and 7.2 pounds product/1,000 square feet for application 3; Defend at 3.1 fluid ounces of product/1,000 square feet; Sincocin at 3 fluid ounces of product/1,000 square feet; Early Bird Liquid at 6 fluid ounces of product/1,000 square feet for applications 1 and 2, and then 18 fluid ounces of product/1,000 square feet for application 3. For TAG, Defend and TAG + Defend, a single application was made on Oct. 13, 2014. For the two-application experiment, applications were made on Oct. 13, 2014 and Feb. 27, 2015. For the three-application experiments with TAG, Defend and TAG + Defend, applications were made on Oct. 13, 2014, Dec. 13, 2014 and Feb. 27, 2015. Arrows denote the application dates.

was an inverse relationship between the number of TAG applications and the number of earthworm castings. Ultimately, the greatest reduction in earthworm castings was provided by the treatment with the greatest number of TAG applications.

At the conclusion of the data collection period, single applications of TAG reduced earthworm castings by 23%, while two and three applications reduced earthworm castings by 48% and 82%, respectively. The reductions in earthworm castings as a result of the TAG applications were similar to those

provided by mowrah meal and crude tea seed meal (10,12,13). Other researchers (12) have noted that superintendents remove earthworms after the application of expellant using a combination of methods such as mowers, blowers, vacuums and water hoses.

One, two and three applications of Defend, Sincocin and Early Bird Liquid did not significantly reduce earthworm casting counts in comparison with the control on most dates. It is somewhat surprising that Early Bird Liquid was not more effective in reducing earthworm castings, as other research has

shown it to be effective. The reasons may be related to the liquid formulation used, the initial rate (the third application applied at 18 fluid ounces/1,000 square feet appeared to be more effective than the initial rate of 6 fluid ounces/1,000 square feet) or some other factor. On average, two and three applications of Defend reduced earthworm castings by 10%. Three applications of Sincocin reduced earthworm castings by 15%, while two applications had no effect. Two and three applications of Early Bird Liquid provided an average earthworm castings reduction of 15%. One,

two and three applications of TAG + Defend reduced earthworm castings counts to levels similar to those provided by TAG applied alone. Therefore, Defend does not provide any added benefits to the control delivered by TAG.

Turf quality

After one and two applications, Defend and TAG + Defend decreased turfgrass quality (Figure 2). [FIGURE2] These results were likely phytotoxic effects of the plant oils within Defend.

Early in the study, TAG, Sincocin and Early Bird Liquid produced little or no effects on turf quality (Figure 2). However, later in the study, two and three applications of TAG and TAG + Defend resulted in increased turfgrass quality, generally as a result of reduced earthworm castings. The greatest turf quality was observed in plots that received three applications of TAG or TAG + Defend. These findings correlate with the reductions in earthworm casting counts; as multiple applications of TAG decreased earthworm casting counts over time, turf quality increased.

A growth response or fertility effect from TAG or Early Bird Liquid was not observed, which is not surprising, because during winter conditions in the coastal Pacific Northwest, turfgrass growth is minimal, and microbial activity, which is necessary for the breakdown of organic fertilizer sources, is also minimal.

Defend applied alone or with TAG did cause a slight phytotoxic response on turf leaves on some rating dates. The turf recovered in two to three weeks.

Conclusions

After the assessment of these four naturally derived products (TAG, Defend, Sincocin and Early Bird Liquid) was completed, TAG was the only product that produced a substantial reduction in earthworm castings and, as a result, improved turfgrass quality. As the number of TAG applications increased, the number of earthworm castings decreased. Three applications provided the highest reduction in earthworm castings (82%) and the highest turf quality at the conclusion of the study. One and two applications of TAG had reduced earthworm castings by 23% and 48%, respectively, at the conclusion of the data collection period. It is also important to note that during our experimentation process, treatments not coupled with rainfall or irrigation

were not effective (data not shown).

TAG, like mowrah meal and crude tea seed meal, generated an expellant response, which caused earthworms to come to the soil surface where they could be removed. TAG is not labeled for control of earthworm castings, but rather as an organic fertilizer for greens and fairways. Registration of this product as a biological pesticide is being pursued, and its ideal use would be repeated applications to provide earthworm suppression.

Turf Tour TAG will be commercially available in the United States as Rhizo Aide (Grigg Brothers, Albion, Idaho). Defend provided no effects on earthworm activity when applied alone or in combination with TAG. Initial applications of Defend did decrease turfgrass quality, suggesting that the plant extracts within the product may cause phytotoxicity.

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The RESEARCH SAYS

- Earthworm castings can be a serious nuisance on golf courses in the transition zone, the Pacific Northwest and Canada, but no pesticides are registered for earthworm control in the U.S. or Canada.
- Researchers tested four naturally derived products: two organic fertilizers, a plant biostimulant and a biologically derived nematicide.
- Turf Tour TAG, an organic fertilizer, was the only product that produced a substantial reduction in earthworm castings and, as a result, improved turfgrass quality.
- Defend did not affect earthworm activity when applied alone or in combination with TAG; Defend decreases turfgrass quality.