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About Fairy Rings and Their Management

Peter H. Dernoeden

Fairy rings are commonly found in turf and pastures and may be caused by any one of 50 or more species of fungi. Fairy rings have been observed in areas where soil pH has ranged from 5.1–7.9. It is likely that fairy rings will occur under any soil condition that will support turfgrass growth. Nearly all of the commonly cultivated turfgrasses are known to be affected by fairy ring fungi. Fairy ring fungi belong to a group known as the basidiomycetes or "mushroom fungi." These fungi can cause the formation of rings or arcs of dead or unthrifty turf, or rings of dark-green, luxuriantly growing grass. Fairy ring fungi primarily colonize thatch and organic matter in soil and generally do not directly attack turfgrass plants, however, some are weakly parasitic. **Fairy rings are classified into three types according to their effects on turf: Type 1:** those that kill or badly damage plants; **Type 2:** those that stimulate grass, causing the formation of rings or arcs of dark-green turf; and **Type 3:** those that do not stimulate grass and cause no damage, but produce mushrooms or puffballs in rings.

The most destructive rings are of the Type 1 variety. Type 1 rings are very common, especially in lawns and golf courses situated on sites that previously had been pastures or woodlands. **Type 1 rings initially appear as circles or arcs of dark-green grass, but the dead zone generally does not appear until summer.** The most common fungi known to cause Type 1 fairy rings include *Agaricus* spp., *Calvata* spp., *Chlorophyllum* sp., *Clitocybe* spp., *Marasmius oreades*, *Lycoperdon* spp., *Scleroderma* sp., and *Tricholoma* spp. The fruiting body of most species is a typical mushroom with a cap and stem. The underside of the mushroom cap is composed of gills, upon which spores are produced. *Calvata* spp. and *Lycoperdon* spp. produce puffballs, which initially are white, fleshy, and egg-shaped. Puffballs turn brown as they age, and when they crack or are crushed they release large numbers of spores. The importance of spores in the spread of fairy ring fungi is unknown.

Type 1 rings are distinguished by three distinct zones: an inner lush zone where the grass is darker green and grows luxuriantly; a middle zone where the grass may be wilted or dead; and an outer zone in which the grass is stimulated and/or darker green. The distance from the inside of the inner zone to the outside of the outer zone may range from a few inches (3–6 cm) to 4 feet (1.2 m) wide. The darker green, stimulated zones are the result of the breakdown of organic matter, which releases nitrogen and results in more vigorous leaf growth. The outer green zone is caused by the breakdown of thatch and organic matter by the fairy ring fungus, which liberates nitrogen. The inner green zone develops in response to the release of nitrogen as bacteria degrade aging or dead mycelium of the fairy ring fungus produced in previous years. Mushrooms or puffballs generally are produced at the junction of the bare and outer green zone. Rings, how-

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ever, may produce few or no mushrooms, especially on closely cut golf or bowling greens. The presence of the three zones may be noticeable from spring to winter.

On golf and bowling greens there may be green rings, dead rings, or dead circular patches surrounded by green rings. **Type 1 fairy rings may also appear on greens as solid circular patches of blue-gray or wilted turf 6 inches to 2 feet (15–60 cm) or greater in diameter.** On young greens, these circular and wilted patches could be confused with take-all (*Gaeumannomyces graminis* var. *avenae*) or localized dry spots. Normally, there will be a dark-green stimulated zone around the periphery of brown patches associated with fairy rings on greens. Fairy rings may appear and disappear on young and old greens. **Fairy rings are more numerous in wet years, but are most destructive when weather conditions become hot and dry.**

Type 2 fairy rings are commonplace and can appear in early spring and remain evident until winter. While a Type 2 fairy ring can develop into a Type 1 ring, Type 2 rings generally only affect the aesthetic quality of turf. **Type 2 rings tend to come and go mysteriously, but seem to be most prevalent during wet summer periods.** One of the more unique Type 3 rings found in turf, including greens, is caused by the "birds nest" fungus *Cyathus striatus*. The fruiting bodies of *C. striatus* are tan to gray-brown, nest-shaped, and about 0.25 inch (5 mm) in diameter. Sometimes "birds nest" rings will have two concentric rings of fruiting bodies. They are most often associated with extended rainy weather or excessive irrigation. They are found in the thatch and the nest-like structure will contain several black, egg-shaped bodies called peridioles. These egg-like structures contain spores. These "bird nests" are also commonly found in mulch.

A ring is broken when its mycelium encounters an obstacle such as a rock, pathway, or unfavorable soil condition. The ring may also disappear for no apparent reason. In general, two fairy rings will not cross one another, i.e., at the point of intersection the growth of each ring stops. This obliteration at the point of contact is caused by the production of self-inhibitory metabolites that will also antagonize other members of the same or different fungal species. On slopes, the bottom of the ring is usually open, giving the appearance of an arc rather than a ring. This may be due to the downward movement of self-inhibitory metabolites that prevent fungal development in turf on the lower side of the ring.

Growth of a fairy ring begins with the transport of fragments of fungal mycelium and possibly spores. The fungus initiates growth at a central point and continues outward in all directions at an equal rate. Rings vary in size from 1 foot (30 cm) to 10 feet (3.0 m) or more in diameter, and become larger each year. Rings greater than 200 feet (60 m) across have been reported. The annual radial growth ranges from 3 inches (7.6 cm) to as much as 20 inches (50 cm). The rate of outward movement, as well as overall ring diameter, is determined by soil and weather conditions. **In general, rings grow more rapidly in light-textured and moist soils than in heavy clay and dry soils.** Rings fade in the autumn or winter, but the bare zone remains visible until the turf recovers or the site is overseeded. Loss of ring visibility is due to the general brownish appearance of dormant turf during winter and because the turf is not metabolizing nitrogen in large enough quantities to produce the darker green circles or arcs. Green rings and arcs, however, may be evident during mild winters when soils do not freeze for extended periods. Type 1 rings are most conspicuous during hot and dry summer periods, but can fade rapidly with the advent of rainy weather.

Type 1 fairy ring fungi kill vegetation primarily by rendering infested soil impermeable to water. Probing will reveal that soil in the dead zone is dry when compared to adjacent soil. The dead zone most likely develops in response to an accumulation of fungal mycelium in such large amounts in soil that it prevents entry of rain or irrigation water, and thus plants die as a result of drought stress. It is quite characteristic for grass on the outer edge of the dead zone to display the blue-gray color of turf under drought stress. **When a plug of soil is removed from the edge of an active fairy ring, a white thread-like network of mycelium sometimes may be seen in the thatch layer or clinging to soil and/or roots of grass plants. When environmental conditions are optimum for fungal growth, the white mycelium may be seen on the surface of the thatch layer. Oftentimes, however, no mycelium is evident in the soil or thatch.** Fairy ring infested thatch and soil, however, will almost invariably have a mushroom odor, even if fungal mycelium is not evident. **Some fairy ring fungi, including *M. oreades*, are known to parasitize roots and produce compounds toxic to roots such as hydrogen cyanide. It is likely, however, that most damage to turf can be attributed to the fungal mycelium rendering the soil impermeable to water.** When soil moisture is abundant, dark-green arcs or rings may be evident, while the dead zone is absent. With the advent of warm to hot and dry weather, however, the dead zone appears. Hence, Type 2 rings can develop into Type 1 rings, and dead zones are most likely to appear during dry summer periods.

Control of fairy rings is made extremely difficult by the water-impermeable nature of the infested soil. Chemical control is frequently ineffective or short-lived because the fungus can grow deeply into the soil and lethal concentrations of fungicide do not come into contact with the entire fungal body. The two most common approaches to combating disfiguring fairy rings are suppression and/or the use of fungicide drenches.

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FEATURE ARTICLE

Another Insecticide Bites the Dust

Daniel A. Potter

Aventis recently requested voluntary cancellation of Turcam® 20% and 76% WP and 2.5 G turf insecticides, and all other products containing bendiocarb, its active ingredient. Turcam was registered for control of white grubs, as well as certain other turf pests (e.g., chinch bugs, sod webworms, mole crickets, and European crane fly larvae). It was also used as a drench for fire ant mounds. Turcam was classified as a restricted use pesticide due to bird and fish toxicity. It was also highly toxic to bees and earthworms. Turcam thus joins diazinon, chlorpyrifos (Dursban®), ethoprop (Mocap®), fonofos (Crusade®), isafofos (Triumph®), and isofenphos (Oftanol®) on the list of organophosphate (OP) and carbamate insecticides canceled or restricted by the EPA since 1990.

Cancellation of Turcam should have little impact on the industry's ability to control surface-feeding pests. Newer, reduced-risk products, especially pyrethroids (bifenthrin [Talstar®], cyfluthrin [Tempo®], deltamethrin [DeltaGard®], and lambda-cyhalothrin [Scimitar®] or spinosad [Conserve®]), work great on cutworms, armyworms, and sod webworms. Liquid halofenozide (MACH 2® 2SC) is also effective against those pests. Chinch bugs and greenbugs can be spot-treated with pyrethroids or controlled by soil-applied imidacloprid (Merit®). Fipronil (Choice®, TopChoice®) is especially effective against mole crickets. For fire ants, several new baits and drench products are generally more effective than was Turcam. For white grubs, most of the industry has shifted to preventive control with Merit or MACH 2.

Loss of Turcam does significantly reduce remaining options for curative grub control, especially "rescue" treatments after damage appears. Turf managers who practice selective preventive control must often spot-treat grub-damaged areas, especially where skunks and other predators are digging. Fast-acting soil insecticides provide the safety net to fall back on an IPM program for grubs.

In the United States, only trichlorfon (Dylox®) and carbaryl (Sevin®) remain for rapid control of large, third-instar grubs. University trials indicate that Dylox® has generally been faster and more consistently effective. Carbaryl also has the drawbacks of high use rate (8 lbs AI/acre), and being highly toxic to earthworms and bees. MACH 2 is also effective as an **early** curative (controls first and second instar grubs), but is it too slow-acting to discourage skunks and other varmints once grub damage appears. Turf managers should support Bayer in defending Dylox®, because its loss would leave few options but preventive control.

Turcam was among the most toxic of turf pesticides to earthworms. Although not labeled for earthworm control, some golf superintendents who used it were probably motivated by the "added value" of suppressing earthworms and castings on closely mowed playing surfaces. Other pesticides that suppress earthworms as a side-effect include Sevin and the fungicide thiophanate-methyl, but neither product is labeled for that purpose. Earthworms are generally beneficial in turf because their activities alleviate soil compaction, increase air and water infiltration, and help to break down thatch.

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Suppression is the most practical approach to combating Type 1 fairy rings in most situations. The suppression approach is based on the premise that fairy rings are less conspicuous and less numerous where turf is well watered and fertilized. **This approach involves a combination of aeration, deep watering, use of wetting agents, and proper fertilization.** Aeration is beneficial since it aids in the penetration of air and water. The entire area occupied by the ring, to include a 2-foot (60 cm) periphery beyond the ring, should be aerified to remove soil cores on 2- to 4-inch (5.0 to 10 cm) centers. The area should then be irrigated to a depth of 4 to 6 inches (10 to 15 cm). Use of a wetting agent should help improve water infiltration. **The ring area should be re-treated in a similar fashion at the earliest indication of drought stress—that is, repeat the process whenever the dark-green grass turns blue-gray and begins to wilt.** When an aerator is not available, a deep root feeder with a garden hose attachment may be useful to force water into the dry soil. Apply recommended

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FEATURE ARTICLE

The Effects of Drought on Weed Control with Postemergence Herbicides

Fred Yelverton

The effectiveness of postemergence herbicides can vary widely depending on a variety of conditions that exist at application. Of course, application rates, spray volumes, size of weeds, and application accuracy and precision are all very important for controlling weeds with postemergence herbicides. However, **a very important aspect of control involves weather conditions around the time of application.** In particular, the physiological growth state of the weeds that are the target of control measures is extremely important. **Weeds that are actively growing are much easier to control than those that are not actively growing.**

What are the conditions that lead to actively growing weeds? There are several, but none are more important that soil moisture. **Drought-stressed plants (weeds) are extremely difficult to kill with postemergence herbicides.** This is because of the effect a lack of water has on the leaf cuticle. Before this relationship is discussed, it is important to understand what the leaf cuticle is and its importance in herbicide uptake.

The leaf cuticle is the outermost layer of all aerial plant parts. It is composed of a complex layer of waxes and the outermost coating of the cuticle is called the epicuticular wax. The cuticle prevents excess water loss from transpiration and provides plants some protection against a variety of things including insects and diseases. This waxy cuticular layer is hydrophobic, which essentially means that it repels water. The best analogy of how water interacts with the cuticle of plants is when wax or polish is applied to a vehicle. When wax is applied to a vehicle, water is repelled due to an increase in surface tension. This is exactly what happens when a spray solution is applied to a leaf surface. Further, the thicker this waxy cuticle is, the more surface tension exists and the more water is repelled.

Leaves that develop under conditions of low soil moisture tend to develop a thicker epicuticular wax than those that develop under high soil moisture. Why is this important to control with postemergence herbicides? Because all postemergence herbicides must be absorbed through this cuticle. **The thicker the cuticle, the more difficult penetration of herbicides becomes.** Less penetration and absorption into the leaf translates into reduced herbicide performance (reduced control).

It is also noteworthy to comment on the roll of stomata in herbicide uptake. The primary roll of stomata in plant growth involves gas exchange and evapotranspiration (plant cooling). In addition, the location of stomata is primarily on the lower leaf surface, although some can be found on the upper surface and there is species-to-species variation in their distribution. But the important point is **stomata have an insignificant roll in the uptake of herbicides. Postemergence herbicides are primarily absorbed through tiny cracks in the leaf cuticle.** And a cuticle that is thin is more easily penetrated than a thick cuticle.

In summary, postemergence herbicide performance will be reduced when applied to drought-stressed plants. This can be alleviated to a significant degree by watering a couple of days prior to application of herbicides if a drought condition exists.

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amounts of nitrogen at the appropriate time of year to help mask fairy rings. Fairy rings, however, can be stimulated by excessive nitrogen or organic matter.

Fungicides are sometimes effective in suppressing Type 1 fairy rings. Aerification followed by drenching with either Bayleton® (triadimefon), Heritage® (azoxystrobin), or ProStar® (flutalonil) have been shown to suppress, but not necessarily eliminate, some fairy rings. A fungicide should be tank-mixed with a wetting agent and watered-in as deeply as possible. For best results, affected sites should be aerified (or at least spiked if core aeration is not an option) and pre-irrigated to moisten soil, thus improving movement of the fungicide and wetting agent into the soil. **Fungicide-wetting agent combinations should be applied in large amounts of water (i.e., 150 gal water per acre; 1,400 L/ha) and watered-in as deeply as possible on a 4-week interval or whenever drought symptoms recur.**