

Effects of Flutolanil Fungicide and Primer Wetting Agent on Water repellent Soil

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SUMMARY. Localized dry spot (LDS) caused by water repellent soil is a common problem on golf course putting greens having a predominately sand root zone. Fairy ring often causes LDS by developing hydrophobic soil. Although the fungicide flutolanil is labeled for the control of fairy ring, golf course superintendents often apply flutolanil to all LDS caused by hydrophobic soil and other conditions. The objective of this study was to determine the effect of flutolanil on an existing hydrophobic soil. The study was conducted on a creeping bentgrass [*Agrostis palustris* (synonym *A. stolonifera*)] experimental golf green in which the top 4 inches (10.2 cm) of the root zone was a moderately hydrophobic sand. Six treatments were used: uncored, cored, flutolanil (two applications.), flutolanil + Primer wetting agent (two applications.), Primer (two applications.) and Primer (three applications.). Plots receiving the fungicide and wetting agent treatments were cored before application. Each treatment containing the wetting agent significantly reduced soil water repellency. Flutolanil without wetting agent had no effect on soil hydrophobicity.

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Localized dry spot (LDS) is the occurrence of an irregular area of turfgrass that for no apparent reason begins to show signs of drought stress (Karnok and Tucker, 1999). There can be many causes of LDS including excessive thatch/mat, soil compaction, salts, soil layering, improper chemical usage, certain fungi and insect pests or poor irrigation coverage (Karnok and Tucker, 2000). A primary cause of LDS on golf greens is the presence of water repellent or hydrophobic soil (Wilkinson and Miller, 1978; Tucker et al., 1990). Water repellency is often associated with soils containing significant amounts of sand (Wilkinson and Miller, 1978). Golf greens often contain more than 90% sand [United States Golf Association (USGA), 1989].

Most researchers agree that soil water repellency is the result of organic compounds derived from living and/or decomposing plants and microorganisms (Doerr et al., 2000). The exact origin of these organic compounds is not completely understood. In some cases, the origin appears to be associated with particular types of vegetation and/or their decomposition (McGhie and Posner, 1981). In other cases, water repellency has been associated with fungal growth and soil microorganisms (Doerr et al., 2000). For example, fairy ring is the name commonly given to circles of mushrooms or lush green circular bands observed in established turfgrass areas (Couch, 1995). Often associated with these characteristics is the development of a zone of water repellent soil (Couch, 1995; Fidanza et al., 2000). In many cases, fairy ring can result in the occurrence of LDS. Although there are more than 50 species of fungi that cause fairy ring, all appear to be soil inhabiting, basidiomycete-type or mushroom fungi (Fidanza et al., 2000). Fairy ring or basidiomycete-type fungi may cause LDS in several ways. The breakdown of organic matter, thus providing the organic compounds necessary for soil water repellency may be responsible for drought-like symptoms associated with fairy ring (Couch, 1995). The presence of thick fungal mycelia which may prevent the movement of water into the soil may also be responsible (Couch, 1995). It has also been postulated that toxic metabolites of certain species of fairy ring fungi may also be responsible for LDS (Filer, 1966). Most likely it is a combination of these

three scenarios that cause LDS (Karnok and Tucker, 1999).

The fungicide flutolanil (N-[3-(1-methylethoxy) phenyl]-2-(trifluoromethyl) benzamide) is labeled for the control of fairy ring. It can be used as a preventative or curative method of control of some fungal species that cause fairy ring (Fidanza, et al., 2000). To ensure movement into the soil, it is recommended that flutolanil be applied with a soil wetting agent (Fidanza, et al., 2000). Early treatment with flutolanil will prevent the formation of LDS caused by fairy ring (Fidanza, et al., 2000). However, a common practice among some turfgrass managers is the use of flutolanil whenever signs of fairy ring, LDS, or water repellent soil become apparent (Karnok and Tucker, 1999). The belief is flutolanil will cure or lessen the severity of water repellent soil and thus LDS (Karnok and Tucker, 1999). Therefore, the objective of this study was to determine if flutolanil reduced the severity of an existing hydrophobic soil.

Materials and methods

The experiment was initiated on 9 June 1998 on the University of Georgia Water Repellent Experimental Golf Green in Athens, Georgia. The green was constructed according to USGA specifications (USGA, 1989) except that the upper 4 inches (10.2 cm) of root zone mix consisted of water repellent sand. The sand was obtained from an old abandoned research green on the University of Georgia campus. The green had exhibited severe LDS caused by water repellent soil for many years. The water repellent sand was harvested by removing the entire top 2 inches (5.4 cm) of sod and root zone mix and passing it through a wire sieve. The water repellent experimental green was established to 'Crenshaw' creeping bentgrass, that was sodded on 17 May 1996. The green was mowed at 0.25 inch (0.625 cm) and irrigated as needed to prevent wilt. Nitrogen was applied at 7 lb/1000 ft² (341.8 kg ha⁻¹) annually as ammonium nitrate (32N-0P-0K) and the other nutrients maintained at satisfactory or above levels according to soil testing. Pesticides were applied as needed for the control of insects and diseases.

On 9 June 1998, the following treatments were applied to 2 x 2-ft (0.61-m) plots: uncored control, cored control, flutolanil (two applications),

flutolanil + Primer (polymeric polyoxyalkylenes and oxoalkenyl hydroxy polyoxyalkane diyl) wetting agent (two applications) (Aquatrols Corp. Cherry Hill, N.J.), Primer (two applications), Primer (three applications). Flutolanil is sold under the trade name Prostar 50WP or 70WP (Aventis Environmental Science, Montvale, N.J.). Primer is a popular wetting agent commonly used with Prostar for the control of fairy ring. With the exception of die uncured control plots, the plot area was cored before treatment application on 9 June, 9 July, and 7 Aug. 1998. The area was cored with a Greensaire aerifier having 0.375-inch-diameter (0.95-cm) tines on 2-inch (5.1-cm) centers. Coring depth averaged about 3 inches (7.6 cm). The area was not topdressed following coring. A CO₂ backpack sprayer calibrated to deliver 2 gal/1000 ft² (814.9 L ha⁻¹) was used to apply the Primer treatments at 6 fl oz/1000 ft² (19.1 L ha⁻¹). Primer was applied with flutolanil on 9 June and 9 July. The two applications of Primer were applied on 9 June and 9 July, while the three application treatment of Primer was made on 9 June, 9 July and 7 Aug.. The Primer treatments were irrigated immediately after application with 0.5 inch (1.25 cm) of water. Prostar was applied at 6 oz/1000 ft² (18.3 kg ha⁻¹) in 30 gal/1000 ft² (12,223 L ha⁻¹) of water. The flutolanil treatments were applied 24 h after the Primer applications.

Visual color (1 = brown, 9 = dark green) and quality (1 = poor, 9 = excellent) ratings were made on 9 June (before initial treatment application), 24 June, 9 July, 7 Aug., and 24 Aug. 1998. Turfgrass quality refers to uniformity, density, color, smoothness, leaf texture, and growth habit (Beard, 1972). Both color and quality rating systems used in this investigation are the accepted rating systems used by turfgrass researchers throughout the United States. Soil water repellency was determined by the molarity of ethanol droplet (MED) technique (King, 1981). Five soil samples per plot were taken on 9 June (before treatment initiation), 24 June, 9 July, 7 Aug., and 24 Aug. 1998. Samples were dried for 24 h at 95 °F (35 °C), then sieved through a #10 United States Standard Series (2-mm) mesh screen. To ensure a uniform surface and depth for the MED test, soil was placed in a 2-inch-diameter x 0.39-inch-deep (5.1 x 1.0-cm) dish. The MED test was conducted by placing a series of 40 uL

Table 1. Color and quality of 'Crenshaw' creeping bentgrass as affected by flutolanil fungicide and Primer² wetting agent.

Treatment	9 June (initial) ¹		24 June		9 July		7 Aug.		24 Aug.	
	Color ³	Quality ⁴	Color	Quality	Color	Quality	Color	Quality	Color	Quality
Uncored control ⁵	7.8 a ⁶	7.6 a	7.0 a	7.3 a	6.8 b	7.1 a	6.4 c	6.1 b	6.5 a	6.1 c
Cored control	8.0 a	7.9 a	7.1 a	7.4 a	6.8 b	7.3 a	6.5 bc	6.5 ab	6.6 a	6.4 bc
Flutolanil + Primer (2 applications)	8.0 a	7.9 a	7.5 a	7.6 a	7.5 a	7.5 a	6.6 bc	7.0 ab	7.0 a	6.9 ab
Flutolanil (2 applications)	7.8 a	7.6 a	7.4 a	7.5 a	7.3 ab	7.4 a	6.9 abc	6.9 ab	6.9 a	6.9 ab
Primer (2 applications)	7.6 a	7.6 a	7.6 a	7.5 a	7.5 a	7.6 a	7.4 a	7.3 a	7.0 a	7.1 a
Primer (3 applications)	7.8 a	7.6 a	7.4 a	7.3 a	7.1 ab	7.1 a	7.1 ab	6.9 ab	7.0 a	6.6 abc

¹Primer soil wetting agent (polymeric polyoxyalkylenes and oxoalkenyl hydroxy polyoxyalkane diyl), Aquatrols, Cherry Hill, N.J.

²Ratings taken before initial treatment application.

³Color - 1 = brown, 9 = dark green.

⁴Quality - 1 = very poor quality, 9 = excellent quality. Quality is a measure of turfgrass texture, smoothness, growth habit, color, uniformity, and density.

⁵Coring is a method of cultivation in which small soil cores are removed by hollow tines or spoons.

⁶Means in the same column joined by the same letter are not significantly different at the 0.05 level of probability according to Duncan's multiple range test.

aqueous ethanol droplets at 0.4 molar intervals on the surface of the soil. The molarity of the droplet that completely infiltrated the soil within 5 s was determined as the MED or water repellency value. Soil having no water repellency would have a MED value of 0 while a MED value of 4.0 would indicate extreme soil hydrophobicity (Doerr et al., 2000).

The experimental design was a randomized complete block with four replications. Data were subjected to analysis of variance (ANOVA) procedures with treatment means separated by Duncan's multiple range test at $P = 0.05$.

Results and discussion

TURFGRASS COLOR AND QUALITY.

There were no differences in color or quality before treatment application (9 June) or 2 weeks after application on 24 June (Table 1). Although there were no differences in quality on 9 July, turfgrass color ratings were significantly higher for turf treated with both the flutolanil + Primer and Primer (two applications.) treatments compared to the uncored and cored controls (Table

1). On 7 Aug. turf treated with Primer (two applications.) had higher color ratings than both controls, while flutolanil and flutolanil + Primer were not different from the controls. The highest quality rating was shown by Primer (two applications.) on this date. There were no turf color differences among the treatments on the last rating (24 Aug.), however, flutolanil, flutolanil + Primer, and Primer (two applications.) treated plots had higher quality ratings than the uncored control. There were no phytotoxic effects by any of the treatments at any time during the study. Although not statistically significant, the turfgrass appeared to benefit from coring. Coring has been shown to relieve the effects of soil water repellency and facilitate the downward movement of wetting agents into the root zone (Wilkinson and Miller, 1978). Flutolanil alone or in combination with Primer had no or little effect on turfgrass color or quality. Again, this would be expected since there was no evidence of fairy ring in the plot area at the time of the study. Flutolanil has been shown to be very effective at reducing the symptoms of fairy ring

incited by *Lycoperdon* sp. (Fidanza et al., 2000).

SOIL WATER REPELLENCY. There was no significant difference in soil water repellency for all plots before the application of treatments on 9 June (Table 2). The degree of water repellency (MED 2.4 to 2.5) would be considered moderately high (Doerr, et al., 2000). On 24 June, 9 July, and 7 Aug., both Primer treatments and the flutolanil + Primer treatment had significantly lower MED values than both controls and the flutolanil treatment. Wetting agents have been shown to be very effective in reducing soil water repellency and are the primary management strategy for ameliorating water repellent soil (Wilkinson and Miller, 1978; Kostka et al., 1997, Karnok and Tucker, 1999). The last measurement date, 24 Aug., showed all the treatments containing wetting agent had significantly lower MED values than both controls. Again, flutolanil did not reduce water repellency. The MED of 0.7 for Primer (three applications.) was lower than all treatments on this date. This would be expected since the recommended application frequency

Table 2. Soil water repellency as affected by flutolanil fungicide and Primer² wetting agent.

Treatment (initial)	Soil water repellency (MED) ¹				
	9 June ²	24 June	9 July	7 Aug.	24 Aug.
Uncored control ³	2.5 a ⁴	2.2 a	1.8 a	1.8 a	1.8 a
Cored control	2.5 a	2.2 a	1.8 a	1.8 a	1.7 a
Flutolanil + Primer (2 applications)	2.5 a	1.5 b	1.0 b	0.7 b	1.2b
Flutolanil (2 applications)	2.4 a	2.2 a	1.9 a	1.8 a	1.6 ab
Primer (2 applications)	2.5 a	1.4 b	1.1 b	0.9 b	1.2 b
Primer (3 applications)	2.5 a	1.5 b	0.9 b	1.0 b	0.7 c

¹Primer soil wetting agent (polymeric polyoxyalkylenes and oxoalkenyl hydroxy polyoxyalkane diyl), Aquatrols, Cherry Hill, N.J.

²MEDs taken before initial treatment application.

³Soil water repellency - 0 = non-water repellent, 4 = extremely water repellent.

⁴Coring is a method of cultivation in which small soil cores are removed by hollow tines or spoons.

⁵Means in the same column joined by the same letter are not significantly different at the 0.05 level of probability according to Duncan's multiple range test.

for Primer is every 30 d. These data show that flutolanil alone has no effect on reducing water repellency of an existing hydrophobic soil. However, flutolanil applied at the first signs of fairy ring may prevent the development of soil water repellency.

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