Suppression of Dollar Spot on Creeping Bentgrass and Annual Bluegrass Turf with Compost-Amended Topdressings

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ABSTRACT

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Topdressings formulated with mixtures of sand and various composts or organic fertilizers (70:30, v/v) were applied to putting greens of creeping bentgrass and annual bluegrass and evaluated for their ability to suppress dollar spot disease development. When applied as preventive treatments at monthly intervals, topdressings amended with selected commercial organic fertilizers composed of animal and plant meals were highly suppressive to dollar spot consistently over a 3-yr period. The level of suppression in some experiments did not differ from that of the fungicide propiconazole. Additionally, a poultry litter compost and a 2.5-yr-old sludge compost from Endicott, New York, also were consistently suppressive to dollar spot. All effective amendments remained suppressive for up to 1 mo after application, but by 2 mo after application, dollar spot incidence did not differ among treatments. When curative treatments of a poultry-cow manure compost, a sludge compost, and an organic fertilizer composed of animal and plant meals were compared with the fungicide iprodione, only the organic fertilizer and the poultry-cow manure compost were effective in reducing dollar spot severity. Results indicated that application of certain composts and organic fertilizers to golf course turf may suppress dollar spot symptoms as effectively as conventional fungicides.

Additional keywords: biological control, cultural control, *Sclerotinia homoeocarpa*

Dollar spot, caused by *Sclerotinia homoeocarpa* F.T. Bennett, is one of the more common and damaging diseases affecting golf course turfgrasses worldwide (27,28). Although fungicides are often relied upon for effective disease management, disease incidence and severity may be reduced by maintaining adequate soil moisture (7,28) and fertility (2,6,11,12,16).

Turf grown under reduced levels of nitrogen is sometimes more susceptible to dollar spot damage than turf maintained at adequate fertility levels (27,28). In general, nitrogen applications are considered to reduce the severity of dollar spot (2,6,16). From among the nitrogen sources tested, Markland et al (16) observed the greatest reductions in disease incidence following applications of composted sewage sludge. Similarly, although Cook et al (6) found no significant reduction in dollar spot severity after applications of inorganic nitrogen fertilizers, reductions were significant after applications of composted sewage sludge. These reductions were greater than could be explained from the nitrogen alone, suggesting that other chemical or biological factors might be involved.

Organic soil amendments are known to suppress soilborne plant diseases (5,30). Composted substrates, in particular, are suppressive to a wide variety of soilborne pathogens (10). Although a number of complex factors may be involved in disease suppression by organic amendments and composts, disease-suppressive properties are largely a result of the microbial attributes of the organic amendment or of the impacts on the native soil microflora following organic matter applications (1,10,24).

Fungal and bacterial antagonists from disease-suppressive composts have been described (13,14,22,25,26,31), and relationships between microbial activity and pathogen suppression have been established (3,4,15). Nelson et al (22) found species of *Trichoderma* from suppressive composts to be the most important fungal components involved in the suppression of *Rhizoctonia solani*. Additionally, Kwok et al (14) identified a number of bacterial species effective in suppressing *R. solani* in bark composts. However, strains of *Enterobacter cloacae*, *Flavobacterium balustinum*, *Xanthomonas maltophilia*, and various fluorescent *Pseudomonas* species were more effective when combined with *T. hamatum* (14). Compost-inhabiting antagonists of other plant pathogens have been studied in less detail. Various oligotrophic *Pseudomonas* species from composts can be effective root colonists and antagonists of *Pythium ultimum* (29), and thermophilic strains of *Bacillus subtilis* in some composts are effective in inducing suppression to *Pythium* species and other soilborne plant pathogens (25,26).

Composts have been used successfully for the control of soilborne diseases in fruits, vegetables, and container-grown ornamentals (10). However, little is known about their utility in managing turfgrass diseases. The purpose of the present study was to determine whether composted materials as well as some uncomposted, commercially available organic fertilizers could be used for the biological control of dollar spot disease development on golf course putting greens.

MATERIALS AND METHODS

Topdressing preparation. Composts and organic fertilizers used in this study were analyzed for available nutrients at the Cornell Nutrient Analysis Laboratory, and their composition and chemical properties are listed in Table 1. All materials were screened to pass through a 2.0-mm-opening sieve before use in topdressing mixtures. Organic components were mixed with fine quarry sand (pH 7.5) in the proportions of 30% organic component and 70% sand (v/v). This mixture was chosen to represent the maximum amount of organic matter that would typically be applied to a golf course putting green during commercial topdressing applications. Topdressings were placed in small styrofoam cups or plastic bags and stored at room temperature until application to plot areas.

Description of field sites. Field plots were established in 1988 and 1989 on putting greens of creeping bentgrass (*Agrostis palustris* Huds.) and annual bluegrass (*Poa annua* L.) at the Country Club of Rochester (CCR), Rochester, New York, and in 1990 on an experimental putting green at the Cornell University Turfgrass Field Research Laboratory (CUTFRL), Ithaca, New York, to evaluate various composts and organic fertilizers for their ability to suppress dollar spot.

Putting greens at CCR were over 60 yr old and constructed from the native alkaline clay loam soil (pH 7.2) in the area. They contained mixtures of bentgrasses and annual bluegrass and were naturally infested with *S. homoeocarpa*. Greens were mowed at a 5-mm cutting height and aerated (0.6-cm-diameter tynes) 1 day before application of treatments. In 1988, greens received the following fertilizer inputs following application of treatments: a granular 18-

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Table 1. Composition and nutrient availability in composts and organic fertilizers used in this study

Material[a]	Composition	Available nutrients[b] (μg/g material)										
		pH[c]	NO_3[d]	P[e]	K[f]	Ca[f]	Mg[f]	Fe[f]	Mn[f]	Zn[f]	Cu[f]	Al[f]
Organic fertilizer CP	Plant and animal by-products	6.6	81	3,845	5,010	2,805	802	49.0	35.0	3.00	1.0	26.0
Organic fertilizer GR	Plant and animal by-products	6.5	24	2,889	26,627	1,577	1,578	40.4	50.2	2.95	0.9	0.9
Turkey litter	Turkey litter	6.2	9	3,685	13,358	2,671	2,608	24.8	75.6	2.54	0.6	0.6
EG manure	Chicken-cow manure	6.9	4,178	5,065	14,805	19,923	2,876	3.5	57.1	1.02	1.1	15.0
Paygro manure	Cow manure	5.0	853	2,375	2,629	4,151	739	3.0	47.8	1.01	2.1	21.3
IPS manure	Poultry-cow manure	7.1	4,164	8,337	14,867	18,743	3,965	12.5	83.0	0.94	1.1	45.3
MH manure	Horse manure	6.7	1,316	858	5,020	4,900	1,422	6.6	44.6	0.39	0.6	8.1
Spent mushroom	Horse manure, straw, and soil	7.3	1,134	1,147	6,993	17,377	1,481	4.8	21.8	0.53	0.9	15.0
AB brewery	Brewery waste	6.5	1,294	2,923	7,671	6,980	2,590	3.1	46.8	0.69	0.8	8.9
Endicott sludge	Sewage sludge	5.6	1,343	832	124	792	108	1.6	6.6	0.16	1.6	7.0
Schenectady sludge	Sewage sludge	5.9	2,864	1,111	1,553	13,910	1,677	13.2	76.2	3.35	5.9	21.0
Baltimore sludge	Sewage sludge	4.9	1,689	886	1,088	14,495	2,236	76.5	93.9	12.95	1.1	40.5

[a] All materials except organic fertilizers CP and GR were composted.
[b] Extracted with Morgan's solution: 10% sodium acetate in 3% acetic acid buffered to pH 4.8, using a 1:5 (v/v) ratio of soil to solution.
[c] Determined in a 1:1 (v/v) suspension of soil and water.
[d] Determined by an automated hydrazine reduction method.
[e] Determined by a stannous chloride reduction method.
[f] Determined by atomic absorption.

0-18 fertilizer on 11 May and 8 September at the rate of 146 kg/ha; a liquid 28-8-18 fertilizer on 18 July at the rate of 43 L/ha; and a 6-2-0 formulation (composted sewage sludge) on 17 November at the rate of 976 kg/ha. In 1989, the following fertilizers were applied: an 18-4-10 fertilizer on 12 May and 12 June at the rate of 146 kg/ha, and a liquid 28-8-18 formulation on 19 September at the rate of 86 L/ha.

The putting green at CUTFRL was 12 yr old and contained mixtures of creeping bentgrass (cv. Seaside) and annual bluegrass. The green was mowed at a 5-mm cutting height and aerated (0.6-cm-diameter tynes) 1 day before application of treatments. No fertilizers were applied in 1990 before or after the establishment of treatments. One application of fosetyl Al was made on 23 May 1990 at the rate of 0.73 g a.i./m^2 to control root-rotting *Pythium* species.

Application of treatments. Preventive dollar spot treatments were applied on 26 May 1988 to 0.9 × 1.5 m plots at the rate of 500 cm^3 of topdressing formulation per square meter. Topdressings were distributed by hand as uniformly as possible over the plot area, then lightly rubbed in to distribute the material into the turf canopy. Control plots were those to which no topdressing was applied. All plots were then watered with 0.6 cm of irrigation. Since disease symptoms did not appear until 5–6 wk after application, all plots were evaluated for dollar spot severity 2 mo after application either by counting the number of spots per plot or by evaluating disease severity on a scale of 0 to 10, for which 0 = no disease and 10 = 100% of plot area diseased. Disease severity ratings were used when the number of spots per plot area became too numerous to count or the distribution of spots was such that they could not be individually resolved.

In order to assess the efficacy of curative applications of topdressings amended with compost or organic fertilizer in suppressing dollar spot infections, plots established in 1988 were left untreated for 6 wk (from 29 July to 8 September) to allow symptom development to reach high levels in all plots. On 8 September 1988, plots were rated for disease severity, and curative treatments were applied at the same rates as for the preventative treatments. The fungicide iprodione was applied at the rate of 0.61 g a.i./m^2 as a fungicide standard. Disease severity was evaluated 2 wk after application.

In 1989, plots were established on a second putting green at CCR to compare the suppression of dollar spot by amended topdressings and the fungicide propiconazole. Treatments were applied initially on 25 May 1989 to 0.9 × 0.9 m plots at the rate of 500 cm^3/m^2 and applied at monthly intervals thereafter. Propiconazole was applied at the rate of 0.17 g a.i./m^2. Controls were untreated plots. Plots were rated for disease severity at monthly intervals. Similarly, in 1990 treatments were applied initially to a putting green at the CUTFRL on 5 June 1990 to 0.9 × 0.9 m plots at the rate of 500 cm^3/m^2. Subsequent applications were made on 18 July and 16 August. Propiconazole was applied at the rate of 0.17 g a.i./m^2 on each of the application dates. Controls were untreated plots. Plots were rated for disease severity at monthly intervals as described above.

All plots were arranged in a randomized complete block design with five replications. Data were analyzed by analysis of variance and means were separated using the least significant difference test.

Table 2. Comparison of amended topdressings for suppression of dollar spot on a putting green in 1988[a]

Topdressing amendment[b]	Preventive application		Curative application	
	Spots per plot[c]	Disease reduction[d] (%)	Disease rating[e]	Disease reduction[d] (%)
Untreated control	41.0	...	5.5	...
Schenectady sludge compost	35.6	13.2	5.8	0.0
Iprodione	33.8	17.6	4.8	12.8
IPS manure compost	26.5	35.4	4.4	18.2
Organic fertilizer CP	9.4	77.1	3.0	45.5
LSD ($P = 0.05$)	20.2	...	1.1	...

[a] Preventive treatments applied on 26 May. Curative treatments applied 8 September.
[b] Treatments applied at the rate of 500 cm^3/m^2 as a topdressing composed of a 30% organic component and 70% fine sand (v/v).
[c] Number of spots per 1.39 m^2 plot. Plots evaluated on 27 July, 43 days after application.
[d] Determined as a percentage of untreated plots.
[e] Rated on a scale of 0–10, where 0 = no disease and 10 = 100% of the plot area symptomatic. Plots evaluated on 20 September, 12 days after application.

RESULTS

Field experiment—1988. A poultry-cow manure compost (IPS manure compost) and a composted municipal sludge (from Schenectady, New York) were compared with an uncomposted organic fertilizer (organic fertilizer CP) and the fungicide iprodione for the suppression of dollar spot. When applied as a preventive treatment, only the uncomposted organic fertilizer was effective in reducing dollar spot incidence, providing 77% disease reduction

up to 43 days after application (Table 2). Following application of materials to plots, rapid greening and enhanced growth of the turf were observed within four days only in plots treated with the uncomposted organic fertilizer. No discernible greening was observed at any time following application of the poultry-cow manure or sludge compost. By 43 days after application, iprodione was ineffective in reducing dollar spot incidence, and no change in turfgrass color or quality was noted on those plots during this 43-day period.

When applied as a curative treatment to highly diseased turf (average disease rating of 5.8), the uncomposted organic fertilizer and the poultry-cow manure compost significantly reduced dollar spot severity up to 12 days after application. The sludge compost and iprodione were ineffective in reducing dollar spot severity.

Field experiment—1989. More extensive comparisons were made between different types of composts and their effects on dollar spot incidence in 1989. One month after the first application of treatments, only uncomposted organic fertilizers (organic fertilizers CP and GR) and propiconazole reduced the incidence of dollar spot (Table 3). As in 1988, greening was observed in plots treated with the uncomposted organic fertilizers. Similarly, plots treated with a turkey litter compost also greened rapidly. The level of control provided by all composts and organic fertilizers tested ranged from none to 70.6%.

One month after the second application of treatments, dollar spot incidence was greater and differences among treatments were more apparent. Of the amendments tested, the uncomposted organic fertilizers, turkey litter compost, Endicott sludge compost, and propiconazole remained suppressive. The level of control provided by all composts and organic fertilizers tested ranged from none to 73.7%. A spent mushroom compost, a horse manure compost (MH manure compost), and the Schenectady sludge compost slightly enhanced dollar spot development.

Field experiment—1990. Dollar spot symptoms on an experimental putting green in Ithaca, New York, were slow to develop in 1990. Symptoms did not appear in untreated plots until early September. Despite the low level of dollar spot incidence at the first rating, all composts and organic fertilizers tested, with the exception of MH manure compost, reduced the incidence of dollar spot (Table 4). The level of control among all composts tested ranged from 33 to 100%. By 63 days after the last application in August, disease incidence was substantially greater. However, there was significant variability among treatment replicates and, as a result, nearly all of the treatments provided no significant ($P = 0.05$) level of dollar spot suppression compared with untreated plots. Only the turkey litter compost remained suppressive 63 days after application. The level of control among all composts and organic fertilizers tested ranged from none to 49.8%. Although differences among other treatments were not statistically significant, fewer dollar spot patches were found in plots treated with uncomposted organic fertilizer CP, Endicott sludge compost, and propiconazole.

Table 3. Suppression of dollar spot on a putting green in 1989 with amended topdressings[a]

	Disease rating 1[b]		Disease rating 2[c]	
Topdressing amendment	Spots per plot[d]	Disease reduction (%)	Spots per plot	Disease reduction (%)
Schenectady sludge compost	5.6	0.0	21.4	0.0
Spent muchroom compost	4.1	0.0	21.8	0.0
Turkey litter compost	3.5	0.0	13.8	30.3
Untreated control	3.4	...	19.8	...
Baltimore sludge compost	3.4	0.0	17.3	12.6
MH manure compost	3.0	11.8	20.2	0.0
AB brewery compost	2.9	14.7	17.8	10.1
IPS manure compost	2.4	29.4	16.9	14.6
Endicott sludge compost	2.2	35.3	13.0	34.3
Propiconazole	1.4	58.8	0.6	97.0
Organic fertilizer CP	1.2	64.7	5.2	73.7
Organic fertilizer GR	1.0	70.6	6.8	65.6
LSD ($P = 0.05$)	1.6	...	5.9	...

[a] Applied on 25 May and again on 26 June to a putting green at the Country Club of Rochester, Rochester, New York, at the rate of 500 cm^3/m^2 as a topdressing composed of a 30% organic component and 70% fine sand (v/v).
[b] Evaluated on 26 June, 30 days after the first application.
[c] Evaluated on 19 July, 23 days after the second application.
[d] Number of spots per 0.81-m^2 plot.

Table 4. Suppression of dollar spot on a putting green in 1990 with amended topdressings[a]

	Disease rating 1[b]		Disease rating 2[c]	
Topdressing amendment	Spots per plot[d]	Disease reduction (%)	Spots per plot	Disease reduction (%)
Untreated control	3.0	...	26.0	...
MH manure compost	2.0	33.3	21.8	16.2
Endicott sludge compost	1.0	66.7	15.5	40.4
Paygro manure compost	0.8	73.3	19.8	23.8
EG manure compost	0.8	73.3	18.0	30.8
AB brewery compost	0.5	83.3	18.8	27.7
Organic fertilizer GR	0.3	90.0	23.5	9.6
Turkey litter compost	0.3	90.0	11.8	54.6
Organic fertilizer CP	0.0	100.0	14.8	43.1
Propiconazole	0.0	100.0	15.5	40.4
LSD ($P = 0.05$)	1.6	...	14.1	...

[a] Applied on 5 June, 18 July, and 16 August to a putting green at the Cornell University Turfgrass Field Research Laboratory, Ithaca, New York, at the rate of 500 cm^3/m^2 as a topdressing composed of a 30% organic component and 70% fine sand (v/v).
[b] Evaluated on 4 September, 19 days after last application.
[c] Evaluated on 18 October, 63 days after last application.
[d] Spots per 0.81-m^2 plot.

DISCUSSION

Results of this study support previous findings (6,16) that certain composted and uncomposted organic fertilizer sources can suppress dollar spot disease development on established turf. In particular, selected composts prepared from turkey litter and sewage sludge (Endicott sludge compost) as well as uncomposted blends of plant and animal meals (organic fertilizers CP and GR) were consistently suppressive. Additionally, although other composted substrates (e.g., AB brewery compost and IPS poultry-cow manure compost) produced suppression that was inconsistent or did not persist under severe dollar spot pressure, their activity under low disease pressure was encouraging. Similar results have been obtained with these and other composted substrates against a number of other turfgrass diseases (18–21,23).

Our results suggest that both preventive and curative applications of composts and uncomposted organic fertilizers can provide levels of disease control equivalent to those achieved with some fungicides. As curative treatments, some composts and organic fertilizers were superior to iprodione in reducing dollar spot severity. Similarly, preventive

treatments of a number of composts, and especially the organic fertilizer CP, were statistically as effective as propiconazole in reducing dollar spot incidence.

The mechanisms by which composts and organic fertilizers suppress dollar spot are unknown. Although nutrient-poor conditions tend to favor dollar spot disease development (28), the putting greens used in this study were maintained under adequate fertility conditions. There was no evidence of dollar spot suppression arising from applications of nutrients with the composts and organic fertilizers used in this study. In fact, those materials most suppressive to dollar spot (uncomposted organic fertilizers and turkey litter compost) contained extremely low levels of nitrate nitrogen compared with the other treatments. However, since most of the nitrogen in these materials is organic, the ammonium form of nitrogen and not the nitrate form is likely to predominate in nitrogen mineralized from these types of amendments (1). Therefore, nitrate nitrogen relationships may not be valid in predicting the relationship between nitrogen status and disease suppression. Additionally, levels of available phosphorus or potassium had no apparent relationship to dollar spot suppression, suggesting that suppression was not caused by the alleviation of nutrient stresses.

Although a number of complex factors may be involved in disease suppression by composts and other organic amendments, disease-suppressive properties are largely associated with chemical and microbial attributes of the organic amendment or with the resulting impacts on the native soil microflora following applications of organic matter (1,10,24). O'Neill (23) observed that composted municipal sludge applied as a topdressing was suppressive to brown patch on tall fescue turf. Furthermore, she observed that suppression persisted even when the compost had been sterilized by autoclaving, suggesting that a microbial component was not responsible for disease-suppressive properties.

Suppression of dollar spot following applications of some composted substrates such as Endicott sludge, IPS manure compost, and AB brewery compost likely resulted from their microbiological characteristics. In preliminary experiments, suppressiveness to *Pythium* spp. was destroyed by autoclaving (*unpublished*), suggesting that microbial antagonists in these composts may be important for disease suppression. We and others have shown that dollar spot can be suppressed biologically through the application of individual strains of antagonistic bacteria or fungi (8,9,17), so it would not be surprising if microbial antagonists contained in composts were, in part, responsible for dollar spot suppression.

The use of topdressing materials amended with composts and organic fertilizers offers a promising means of incorporating fungicide alternatives into disease control programs. Golf course superintendents routinely topdress greens and tees three to four times a season with a mixture of sand and some type of organic matter (usually peat) or soil, primarily to smooth the putting surfaces and manage thatch accumulation. The application of compost-amended topdressings, therefore, would not introduce additional practices into a turfgrass management program. By simply altering the topdressing amendment, turfgrass managers may be able to convert a relatively inert topdressing material into a biologically active material with fungicidal properties. Although the precise nature of disease suppression remains obscure, studies of the microbiology of suppressive composts may provide insight into ways in which composts and other organic amendments can be used more reliably for disease suppression on established turf.

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