Compost Tea for Control of Dollar Spot

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Introduction

There are increasing societal pressures to limit the use of synthetic pesticides in urban environments. More municipalities are likely to ban the use of pesticides for cosmetic purposes, whether or not there is toxicological justification. In light of this trend, there is a need to seek alternatives. Although biological controls with microbial antagonists have shown promise for the control of pests, these products must also undergo very stringent reviews by the federal government, and the costs of registration are prohibitive in Canada. Opponents of synthetic pesticide use often list alternatives which they claim are as effective if not better than synthetic chemicals. There is a need for rigorous assessment of these claims, and controlled testing of the efficacy of home or folk remedies. One of these home remedy substances is compost teas based on fermentation extracts from various composted materials.

The objective of this study was to produce composts teas from a variety of commercially available composted materials, and to these them for the control of dollar spot disease. Dollar spot is the most common turfgrass disease on high maintenance golf turf, and occurs occasionally on home lawns. Compost teas are made by soaking composts in aerated water and using the water extracts on plants with the goal of improving plant health. A multitude of recipes for compost teas are available. For example, Ingham (2000) suggests creating a well-mixed and well-aerated system such as in a through with air pumps, and steeping 20 lbs of compost in 50 gallons of water for up to 24 hours. Bess (2000) says that there are probably as many recipes for compost teas as there are for chili in Texas, and she reviewed the results from several tests with agricultural plants. In some tests, some compost teas actually enhanced disease and reduced yield. In the experiments below we prepared compost teas from five different composted materials commercially available from local home and garden shops, and first tested their inhibition of the dollar spot fungus in petri plate tests to assess the inhibitory activity and relative microbial activity after various fermentation times. Then in field tests, different dilutions of the compost teas were tested for their efficacy against dollar spot disease on a creeping bentgrass putting green.

Methods & Results

Sources of Compost Material

The materials for making compost teas were purchased in Guelph from retail outlets on 2004/06/21: Country Depot Garden Centre (turkey, mushroom) and Canadian Tire (cattle, sheep, topdressing) and kept at 4 C. A second set was purchased on 2004/8/27 for field tests and kept at 4 C. Compost teas selected for testing, their water content, and the amounts to make a batch of tea are shown in Table 1.

Fermentation process

The composts were loosely placed into 17 L plastic containers (Rubbermaid Canada, Mississauga, Ontario). Plastic tubing (7 mm diameter, Rolf C. Hagen Inc., Montreal, Quebec) was cut to 70 cm lengths and attached to air pumps (Elite 800, Hagen Inc., St. Laurent, Quebec) at one end and to aquarium bubbling stones (Aqua fizz air stone for aquarium use, Elite, Rolf C. Hagen Inc., Montreal, Quebec) at the other end. These air pumps can provide 1.5 L air / min, and each 17 L plastic container was serviced by a single air pump. The bubbling stones were placed under the compost in each container, water was then added to the compost (Table 1), and the bubbling stones adjusted to provide the most bubbling action. The bubbling compost teas were stirred several times a day (vigorous mixing with a stick purportedly allows more organisms to loosen into the tea). After each stirring, the bubbling stones were repositioned for maximum bubbling activity. The duration of bubbling (fermentation) was for up to 8 days. The sampled tea was filtered through cheesecloth to remove large particles and the filtrate was used

for inhibition tests. The filtrate was stored for no more than 7 days before use in any of the tests.

Table 1: Characteristics of materials used to make compost teas

Name	Manufacturer	Contents	Moisture[1] (%)	Amounts to make tea[2]	
				compost	water
Cattle manure (20 kg)	Canadian Tire Corp. Ltd. Toronto Ca.	C/N = 25:1	43	1.88 kg	3.7 L
Sheep manure (20 kg)	Canadian Tire Corp. Ltd. Toronto Ca.	C/N = 20:1	47	2.26 kg	4.0 L
Organic turkey manure (18 kg)	P.O. Box 160 Elmira, ON	NPK = 1-2-1, 2% Organic matter	45	1.34 kg	3.0 L
Organic mushroom compost (18 kg)	P.O. Box 160 Elmira, ON	natural organic soil builder	57	1.69 kg	3.4 L
Topdressing (18 kg)	Hillview Farms Ltd. P.O. Box 1148, Woodstock, ON	manure & compost & sand (probably 70% sand)	60	1.27 kg	3.5 L

[1] Moisture content [(wet weight-dry weight)/wet weight] of each compost out of the bag was measured using three replicates of 30 to 40 g wet weight samples, and oven dried at 80 C for 24 h.
[2] The amount of de-ionized water added to wet weight of compost out of the bag was determined based on the amount necessary to thoroughly soak the compost and allow air to bubble through it.

In vitro inhibition tests

Initial tests with fungal mycelium of the dollar spot fungus, *Sclerotinia homoeocarpa* isolate SH84, on petri plates showed that all five compost teas produced substances that caused inhibition of fungal growth. The inhibition efficacy decreased from cattle, turkey, Topdressing, mushroom to sheep compost teas. For some of the teas, abundant bacterial colonies were produced, so a more detailed investigation of microbial populations was conducted.

Analysis of microbial populations

The number of colony forming units (CFUs) was assessed for compost teas from 1 to 8 days of fermentation. The initial dilution of the composts was 1: 2 (weight/volume) of compost in water. The fermentation system was set up as described above. A serial dilution method was used, beginning with 1 ml of undiluted tea placed into 9 ml of autoclaved water and mixed. After that, 1 ml of this 10H dilution was placed into a second tube with 9 ml of autoclaved water to make a 100H dilution, and so on until the 10^{-6} dilution. Every 24 h for 7 days starting on day 2 (48 h after start of the experiment), 1 ml was taken from the fermentation container and serial dilutions made. From every dilution, an aliquot of 0.1 ml was spread over a plate using a loop. Each plate contained 15 ml of PDA amended with 10 % tartaric acid (1.6 ml of 10 % stock solution per 1000 ml PDA) to retard bacterial growth. Initial tests showed that bacteria were very common in every type of compost, and the numbers overwhelmed the other microbial types so the non-bacterial colonies could not be enumerated. Each dilution was replicated on 4 plates, and the plates were incubated at room temperature (25 C). The target colony counts for fungi were 30-300, and for bacteria, 10-100, so the dilutions showing numbers closest to these were chosen for colony enumeration after 8 days of incubation. The number of colonies of yeast, actinomycetes and fungi were counted (Table 2). The colonies were identified based on the following characteristics on acidified PDA.

Yeast: creamy white or yellow colonies, with rod-shaped cells up to 8 um long

Actinomycetes: characteristically hard colonies, with an earthy smell, fuzzy like a fungal colony with an irregular fuzzy edge; filaments adhered strongly to the medium with a leathery texture. Filaments formed long, threadlike branches that looked like gray spiderwebs stretching through the medium at the outer 10 to 15 mm edge of the colony.

Fungi: fluffy or powdery large colonies of various colors.
Note that although actinomycetes are bacteria, antibiotics such as streptmycin and tetracycline are produced by actinomycetes which are naturally resistant to these substances.

Table 2: Microbial composition in compost teas based with 0.1 ml added to each 9-cm-diam acidified PDA plate

		Number of colonies per plate by days of fermentation						
Compost Tea	Microbial	2	3	4	5	6	7	8
Cattle	Yeast	2	0	2	0	1	7	0
	Actinomycetes					1	1	
	Fungi							
Sheep	Yeast	0	4	11	4	7	10	0
	Actinomycetes						2	23
	Fungi							
Turkey	Yeast	49	35	40	42	36	54	0
	Actinomycetes						48	20
	Fungi					1		
Mushroom	Yeast	2	0	2	1	1	12	0
	Actinomycetes							
	Fungi							
Topdressing	Yeast	5	17	57	14	27	28	0
	Actinomycetes	0					2	1
	Fungi							1

These results indicated that 7 days was a suitable fermentation termination point for the five composts studied in this experiment. At that time, there was a peak number of microbial colonies, with a decrease after that. For non-bacterial microbes, a 10H dilution was suitable for colony counts. The yeast and actinomycetes counts were highest in the turkey compost tea, followed by Topdressing, then sheep, cattle, and mushroom compost teas. In the cattle compost teas, green colonies thought to be *Trichoderma* were observed. *Trichoderma* species are known to be inhibitory to other fungi. *Trichoderma* is characterized by fast-growing hyaline colonies, whitish green to green, with compact tufts of conidiophores. It has repeatedly branched conidiophores in tufts with divergent, flask-shaped phialides, conidiophores side branches short and thick, and the conidia are green and smooth-walled.

Heat stability of compost teas

This experiment was designed to assess the effect of different temperature treatments on the five undiluted compost teas. The teas were placed into different temperatures for various durations (2 ml in 10 ml tubes): 4 C @ 2 h, 50 C @ 2 h, -20 C @ 2 h, autoclaved (15 min at 121 psi). An undiluted 0.1 ml aliquot was spread with a loop over a plate containing 15 ml of PDA amended with antibiotic (100 mg/L

streptomycin and tetracycline PDA), with 3 replications per treatment. After 7 days incubation at 25 C, the number of colonies was assessed (Table 3). Table 3 shows that holding the compost teas at 50 C for 2 h greatly reduced the number of CFUs, whereas freezing did not seem to affect the populations. Microbes were killed by autoclaving @ 15 min. High temperatures generally decreased microbial populations, so it was better to obtain fresh tea before each spraying, and when necessary, store the tea at 4 C or -20 C for short periods.

Even though antibiotics were added, bacteria were still able to grow probably because the counts were so high they overcame the inhibitory effect of the antibiotics, possibly because the antibiotics were from old stocks that lost their efficacy. Nelson & Boehm (2002) stated that in all batches of brewery compost and a few batches of certain municipal biosolids composts, this materials contain relatively high populations of heterotrophic bacteria, actinomycetes and fungi. These populations were eliminated by heating, but could be partially restored by incubating sterilized compost with small amounts of nonsterile material.

Analysis of microbial populations II

Another test was conducted for analysis of microbial populations in compost teas, including bacteria. Teas were generated following the protocols above with 7 day fermentation. A dilution series was made at 10H, 100H and 1000H dilutions. Aliquots of 0.1 ml were spread over PDA plates, with 3 replicate plates per samples. The plates were incubated at 25 C for 5 days and then the colonies were counted (Table 4). Results of Table 4 showed that the mushroom compost had the highest microbial counts, followed by the sheep and topdressing composts.

Table 4: Analysis of microbial populations in compost teas fermented for 7 days and incubated on PDA at 25 C for 5 days.

Dilution	Microorganism	Colonies on PDA plates from 0.1 ml aliquots of various compost teas				
		cattle	sheep	turkey	mushroom	topdressing
10x	yeast	34	68	16	110	10
10x	actinomycetes	9	6			40
10x	bacteria	3	1	67	10	17
10x	fungi	1	4		1	1
100x	yeast	13	8	54	66	78
100x	actinomycetes		4			6
100x	bacteria	6	2	12	6	2
100x	fungi		2	1		
1000x	yeast	63	7	10	118	76
1000x	actinomycetes		2			3
1000x	bacteria		4	2	12	4
1000x	fungi		1			

Field Tests

Plot setup

Treatments were evaluated on a 11yearold sward of Penncross7 creeping bentgrass (*Agrostis palustris*) at the Guelph Turfgrass Institute in Guelph, Ontario. Turfgrass cultural treatments were similar to those used for maintenance of golf course putting greens in Ontario. The plots were irrigated as needed, and mowing height was set at 5 mm. The green had been constructed in 1994 on a soil base of 80% sand and 20% organic matter. Sulphur-coated urea (N-P-K: 25-4-10) was applied three times annually in spring and early and late summer at a product rate of 2 kg/100 m^2. Pathogen inoculum was prepared by incubating four strains of *Sclerotinia homoeocarpa* on autoclaved mixed grains for 1 to 2 weeks. The inoculum was dried and chopped into small particles with a domestic mixer. Inocula from the four strains were combined, and 1 g of inoculum plus 3 g of wheat bran as a carrier were evenly applied to each plot. Inoculum was applied first on 2 July, and then again on 28 July. The weather conditions at the beginning of July had unseasonably cool temperatures 13-24 C with only a few days in the upper 20's. Rainfall was higher than normal which allowed for luxurious grass growth. Even with inoculation, very low levels of disease were observed, so a final inoculation was made using a double rate (2 g inoculum / m^2) on 19 Aug.

Treatments

Five freshly prepared compost teas were used for this experiment at different dilutions (Table 5). Fermentation time was 7 days, with a new batch prepared each week. The teas were fermented at various water dilutions with ratios of 1:2, 1:3 and 1:5 (compost / de-ionized water; w/v). The compost teas were diluted sixfold in water prior to application for a product application rate of 240 ml/m^2 along with a water control at the same rate. Applications generally occurred weekly in the early morning. Conforti et al. (2002) used a spray rate of 1-gallon compost tea/1000 ft^2 which is equivalent to 40 ml/m^2.

Experimental design consisted of a randomized complete block design with 4 replicate 0.5 m H 0.5 m plots. Compost tea plots were first sprayed with tea and inoculated two days later. The treatments are listed in Table 5. During July and most of August, the weather was not conducive to dollar spot development, and the first spots were observed only at the end of August when the weather became warmer and drier (Table 5). Data were subjected to analysis of variance using SAS7 PROC GLM (SAS Institute Inc., Cary, NC). When treatment effects were significant in the analysis of variance (p # 0.05), means were separated by the test of least significant difference (LSD, p = 0.05)

Phytotoxicity was not observed for any of the treatments tests. All of the compost teas showed some disease suppression ranging from 49 to 86%. The mushroom compost showed the most suppressive activity at 1:2 and 1:3 fermentation dilutions, followed by turkey and sheep composts at 1:2 fermentation dilutions.

In comparison, fungicide trials were conducted on adjacent plots. For a standard treatment of Daconil 2787 at 190 ml product / 100 m^2, the equivalent number of spots per 0.25 m^2 was 11 in mid September. For other treatments with mixtures of chlorothalonil and propiconazole, there was no disease visible.

Table 5: Number of dollar spots in plots of creeping bentgrass treated with various materials.

Treatment	Number of dollar spots per 0.5 m H 0.5 m plot							Suppression[a]
	29 Aug	2 Sep	10 Sep	14 Sep	16 Sep	23 Sep	30 Sep	30 Sep
Mushroom (1:2)	11	8	4	19	17	10	10	0.86 gh
Mushroom (1:3)	11	18	15	31	25	16	18	0.75 fgh
Turkey (1:2)	11	11	11	23	20	21	20	0.72 fgh
Sheep (1:2)	13	10	11	21	25	23	21	0.70 fgh
Topdressing (1:5)	22	13	20	39	39	29	24	0.66 efg
Cattle (1:5)	13	16	15	34	35	26	26	0.63 ef
Sheep (1:5)	13	13	11	23	24	26	26	0.63 ef
Cattle (1:2)	14	13	20	38	43	29	26	0.63 ef
Mushroom (1:5)	18	21	15	26	29	29	30	0.58 def
Topdressing (1:2)	18	15	9	28	34	30	30	0.58 def
Turkey (1:5)	18	10	15	41	46	35	36	0.49 cde
Uninoculated	13	12	5	21	13	10	8	
Inoculated	15	27	23	70	93	73	71	
LSD (p= 0.05)	14.1	9.2	11.5	25.3	22.2	14.5	13.8	

[a] Suppression was calculated as (inoculated control - treated) / (inoculated control). Values in this column followed by a letter in common are not significantly different at p=0.05, based on four replicates.

In conclusion, the compost tea in this trial with the most suppressive activity gave suppression of dollar spot at levels similar to a standard dollar spot control treatment with chlorothalonil. However, most of the compost teas provided significantly less suppression than the fungicide control. Perhaps a more concentrated solution of the mushroom compost would have provided even higher levels of suppression. More research needs to be done on the treatments showing the highest suppression as well as further searching for more suppressive materials. Further study is also needed on adjusting the aeration system to maximize the microbial development of the compost tea. Varying the temperature during brewing, testing various catalysts, and ensuring the stability of microbial populations in the compost also need further study, as well as the mechanism of suppression.

Acknowledgments

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