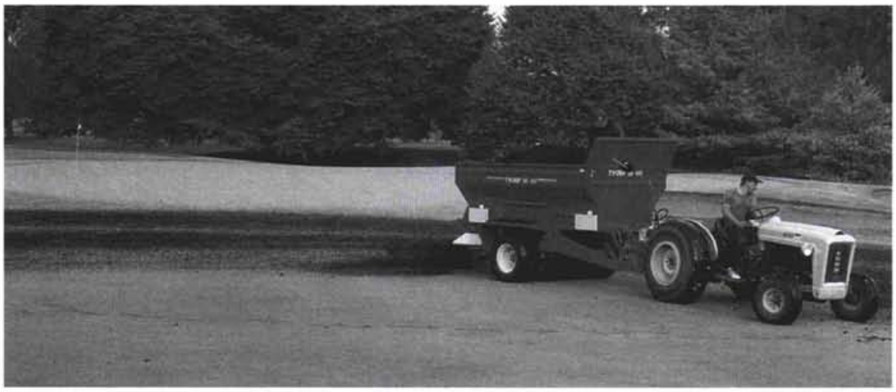
Using Composts to Improve Turf Ecology

F. Dan Dinelli

It is said that *if any of the billions of organisms inhabiting the soil had hands, the fate of the world would be in them.* An important soil function is the harboring of a diverse community of organisms that includes bacteria, fungi, protozoa, nematodes, mites, springtails, millipedes, sowbugs, earthworms and many others. This community drives the decomposition of organic residues; recycles important nutrients like carbon, nitrogen and phosphorus; and contributes to the formation of new soil and soil structure. With these activities, soil organisms contribute to other important soil functions, such as supporting the growth of plants and absorbing, neutralizing and transforming compounds that might otherwise become pollutants in the environment. Basically, soil organisms play a critical role in shaping and maintaining terrestrial communities and ecosystems.



Topdressing fairways with compost.

Testing different composts on bentgrass mowed at 1/8".

As the superintendent at North Shore C.C. in Glenview, IL, I became interested in applying compost as a soil amendment after reading research suggesting its many agricultural benefits. Dr. Michael Boehm, Ohio State University, and Dr. Eric Nelson, Cornell University, have done helpful work, specifically about the effects of compost on turfgrass. Generally, researchers and practitioners recognize that incorporating high-quality compost does several things:

1. Adds food for nearly every kind of organism needed by a healthy soil.

2. Adds a diversity of organisms to the soil.

3. Encourages plant growth-promoting substances in soils. Compost can also have an effect on soil structure, nutrient cycling, disease suppression, nematodes and other biological activity.

In fact, the use of composts on turf is not new. A book given to me by my grandfather, Frank Dinelli (retired greenkeeper at Northmoor C.C.), titled *Turf For Golf Courses,* by Charles V. Piper and Russell A. Oakley, printed in 1917, has a chapter devoted to "Manures, Composts and other Humus Materials." Yet because compost is not widely used on golf courses, I wanted to participate in further research prior to investing in the process at North Shore C.C.

Phase I: Experimentation

In 1996, we got just that opportunity by participating in a two-year study of various composts and organic materials under the direction of Dr. Michael Cole of the University of Illinois and

(continued on page 14)

Using Composts to Improve . . .
(continued from page 12)

GreenCycle, Inc. (operator of several composting facilities) of Northfield, IL. The study was a replicated 10' x 10' plot design on our #5 fairway comprised of creeping bentgrass and Poa annua maintained at 1/2" mowing height. During the field evaluation, all observations were noted. However, our main objective was to observe any disease-symptom differential between the various plots.

Our first application was in the fall of 1996 to observe snow mold *(Gerlachia nivalis, Typhula spp.)* suppression. None of the materials demonstrated any noticeable snow mold suppression. However, plots treated with compost had a notably earlier green-up and recovery rate versus the control plots. We then repeated applications in late spring of 1997. Observations through the remaining growing season showed strong dollar spot *(Sclerotinia homoeocarpa)* suppression—up to 80% reduction; improved turf color and density; and increased earthworm castings. Thus, while our initial objective of snow mold suppression was not observed, our experiment to test organic products as they improve overall turf ecology proved quite successful.

Phase II: Implementation

Based on favorable results after two seasons of field evaluation of compost topdressing, we implemented the strategy on all our fairways. During our normal coring of fairways, the process involves the following steps:

- Coring with hollow tines;
- Breaking up the soil cores with a vertical mower;
- Topdressing with compost;
- Mixing the soil with compost as it is matted into the surface with a section of chain-link fence;
- Blowing the remaining tufts of turf and thatch into rough via a three-point hitch blower;
- Picking up debris in the rough with an out-front rotary mower fitted with a bagging attachment; and
- Irrigating the area well.

'Homemade' compost tea.

We have been coring fairways like this for several years. Adding the extra step of compost topdressing has not significantly impacted the workload. The cleanup is about the same and we can still get our targeted nine holes (15 acres) done in one day.

(Note: Part of our IPM cultural program is poling, by dragging a chain over the fairways each morning to remove leaf moisture and guttation. This process also manages earthworm casting buildup).

Phase III: Results

The results so far are much the same as in the test plots: improved turf density and color, rapid healing of cored turf, dollar spot *(Sclerotinia homoeocarpa)* suppression, increased earthworm castings and thatch reduction have been observed. We continue to monitor the impacts of compost use on turf and maintain computerized spreadsheets to evaluate our results. Over time and continued applications, we hope to document improved soil structure and suppression of other diseases.

Selecting Quality Compost Is Key

Selecting quality compost is very important; you have to do your homework. Compost products are not yet standardized, so the challenge is in obtaining consistent, high-quality compost. The procedure we use to assure the compost we obtain is optimal for our turf involves a series of tests. We analyze chemical, physical and biological activity.

– Chemical Analysis

In the chemical analysis we look for:

- Carbon:nitrogen ratio <20:1, best at 15:1.
- pH at 6.5-8.5.
- None to trace amounts of ammonium, sulfide and nitrite.
- Low concentrations of soluble salts, especially sodium.
- Moreover, we strive towards elemental balance and recommended ratios favoring the high side of potassium and calcium. Also, biosolids need to meet U.S. EPA's Part 503 technical rule for biosolids. All biosolids tested for coliform and other diseases. Biosolids composted properly have been heated sufficiently to kill viruses, coliform and other diseases. Metals in biosolids are often high and should be considered.

– Physical Analysis

Physically we look for:

- Fine texture < or = 1/8".

(continued on page 16)

Using Composts to Improve . . .
(continued from page 14)

- Light, crumbly structure, parent material nonvisible.
- Moisture at 30-40%.
- Dark brown to black in color (caution with dark black compost, for the compost might have gotten too hot and burned).

– Microbiological Analysis

A great diversity of bacteria, fungi, protozoa and beneficial nematodes occur in good compost. Healthy compost has been hypothesized to have between 10,000 to 20,000 species of bacteria per gram. The DNA analysis required to establish the set of species in highly diverse compost awaits molecular microbiologists. The study of microorganisms is very complex and dynamic. Many of the billions of organisms that exist have not yet been described or their functions understood. It is a frontier ready to be explored.

Several laboratories and universities are exploring methods to assess soil and compost microbial activity. Soil Foodweb Inc. has done testing for us, including bacteria, fungi, protozoa and nematode counts. Some feel
(continued on page 18)

		STANDARDS FOR COMPOSTS (SOILS)	AGRI-ENERGY COMPOST	BREW WASTE	EARTHWORM CASTS	GREENCYCLE	BIOSOLIDS	WOOD BIOCOMPOSTE	B & G COMPOST
Sample Number			73	63	72	217	310	554-1	555-1
Date			**3/18/98**	**3/31/98**	**3/18/98**	**5/22/96**	**8/4/97**	**12/17/98**	**12/17/98**
Aerobic Plate			6.00E+08	1.10E-09	4.50E+08	2.50E+09	1.20E+10	2.10E+09	6.00E+08
Anaerobic		10:1 Ana:Aer	1.80E+07	9.40E+08	1.10E+08	2.50E+08	5.30E+08	8.00E+07	2.30E+05
Yeasts/Molds		1E+3 to 1E+4	1.10E+05	1.60E+05	1.40E+06	9.70E+05	1.60E+04	1.70E+05	1.20E+05
Actinomycetes		1e+6 to 1E+8	1.30E+07	1.10E+03	1.10E+07	2.30E+07	2.20E+06	3.10E+07	8.30E+05
Pseudomonads		1E+3 to 1E+6	2.90E+05	<1.00E+02	2.00E+05	2.50E+05	2.10E+06	1.40E+05	3.50E+05
N-Fixing Bacteria		1E+3 to 1E+6	2.00E+04	<1.00E +03	7.70E+05	3.00E+06	1.50E+05	6.70E+05	2.00E+03
Soil Moisture		30 to 40 %	57		85	78	91	76	13
Total Species Richness Diversity						10.4		9.4	3
Total CEC (meq/100g)		>60meq/100g	36.35	6.66	38.56	49.79	36.92	39.54	58.24
pH		6.5 to 8	7.6	5.4	6.7	7	7.4	6.7	7.2
Organic Matter (%)		20 to 35%	13.4	73.2	37.5	28.5	27.1	32.74	9.25
Estimated N Release				>130	>130	>130	>130	121	
PHOSPHOROUS									
Easily Extractable P	P as P2O5		4403	1289	249	2760	10659	2171	11661
	ppm of P		961	281	54	603	2327	474	2546
Bray II	P as P2O5		1085	85	376	1025	1045	916	870
	ppm of P		237	19	82	224	228	200	190
SOLUBLE SULFUR									
	ppm	15 to 40	184	28	188	147	1937	615	753
EXCHANGE CATIONS									
calcium	lb/A		5748	602	10798	10066	6929	10476	7196
	ppm	1300 to 3000	2874	301	5399	5033	3465	5238	3598
magnesium	lb/A		2088	526	1574	2552	3338	1512	3776
	ppm	140 to 300	1044	263	787	1276	1669	756	1888
potassium	lb/A		7940	90	662	8658	1710	2050	11818
	ppm	>140	3970	45	331	4329	855	1025	5909
sodium	lb/A		790	96	280	324	932	360	3182
	ppm	<67	395	48	140	162	466	180	1591
BASE SATURATION %									
calcium	%	60 to 85%	39.53	22.6	70.01	50.54	46.91	66.24	30.89
magnesium	%	8 to 12%	23.93	32.91	17.01	21.36	37.66	15.93	27.01
potassium	%	5 to 8%	28	1.73	2.2	22.29	5.94	6.65	26.02
sodium	%	3%	4.72	3.13	1.58	1.41	5.49	1.98	11.88
other bases	%		3.8	6.6	4.7	4.4	4	4.7	4.2
hydrogen	%		0	33	4.5	0	0	4.5	0
EXTRACTABLE MINORS									
boron		0.4 to 1.5 ppm	1.77	0.61	1.11	5.46	2.88	2.44	3.97
iron		>50 ppm	157	19	288	320	351	363	283
manganese		8 to 35 ppm	85	4	8	60	74	74	120
copper		0.6 to 2 ppm	3.48	0.77	2.61	3.68	14	5.46	21.18
zinc		1.3 to 3.5 ppm	36.8	6.8	4	25.7	198.7	73.27	95.55
aluminum			141	23	28	64	752	711	94

nematodes could be used as a biological indicator. Four basic types of nematodes occur: bacterial-feeders, fungal-feeders, root-feeders and predatory nematodes, which feed on other nematodes. When organisms increase, an increase in those nematodes that feed on them occurs, thus providing an indication of relevance.

BBC Laboratories has also done testing for us (see chart). They analyze concentrations of six groups of organisms, which they feel are "key players" in soil ecology. The following six functional groups tested are:

- Heterotrophic (aerobic) bacteria—Finished compost should have 100 million to 10 billion colony forming units/gram dryweight (CFU/gdw). Compost with less than 100 million CFU/gdw will not perform as well as soil innoculants and may not be effective in suppressing plant diseases.

- Yeasts and molds (fungi)—Finished compost should have between 1,000 and 10,000 CFU/gdw. These organisms are important for breaking down organic compounds, soil nutrient cycling, stabilizing soil aggregates and controlling plant disease.

- Nitrogen-fixing bacteria—The number of free-living nitrogen-fixing bacteria in compost varies a lot depending on the available nitrogen concentration but may be in the range of 1,000 to 1 million CFU/gdw. The populations of these free-living nitrogen-fixing bacteria will proliferate as the available nitrogen in the compost decreases. As a consequence, there is typically an inverse relationship between biologically available nitrogen in the compost and the concentration of free-living nitrogen-fixing bacteria.

- Actinomycetes—Finished compost should have at least 1 million to 100 million CFU/gdw. Compost made with woody materials may have more. These organisms are important for many functions, including the breakdown and nutrient cycling of complex chemical substances such as chitin and cellulose, improving soil crumb structure and assisting in the reduction of plant pathogen pressures. They are particularly efficient in alkaline soils.

- Anaerobic bacteria—The ratio of aerobes to anaerobes in the compost should be at least 10:1 or greater. An overgrowth of anaerobes indicates the compost was not turned with sufficient frequency. It is important that anaerobic by-products in the compost be degraded prior to use with plants of germinating seeds.

- Pseudomonads—Finished compost concentration should be between 1,000 and 1 million CFU/gdw. Depending on starting materials, this number could be lower, but is rarely higher. Pseudomonads are important in nutrient cycling, assisting plants with phosphorus availability, and some have been linked to the biological control of plant pathogens.

In addition, compost needs to be free of contaminants, such as weed seeds, plant parts, pathogens, stones, plastic, glass, wood, nails, etc. Compost also needs to be "mature," testing >50% on the maturity index, by BBC Labs. In-house maturity tests can be performed by planting grass seed in a pot, utilizing the

(continued on page 20)

Using Composts to Improve . . .
(continued from page 18)

intended compost as the growing medium, to observe seedling health and establishment. Another method is to fill a plastic bag with intended moist compost and allowing it to sit sealed in the sun for a few days. Upon opening the bag, the compost should have an earthy smell, not an offensive smell from ammonia or sulfur.

Following these procedures will help insure favorable results. Adverse effects can result when utilizing poor-quality compost. Starting slow and testing small areas first is always helpful. Developing a working relationship with local composters will help in understanding their product.

Additional Uses for Compost with Turf

In addition to our fairway compost topdressing program, we also use compost in our "soil and seed" mix for divot repair. Compost is used as topdressing while overseeding turf. In 1998, we constructed a 7,000-square-foot experimental putting green, featuring 20 different root zone mixes. Each mix used USGA-approved sand in a USGA root zone profile with various organic and inorganic amendments. The 90/10 sand/compost plots outperformed the others considerably in seedling establishment and development. We continue monitoring other effects as the putting green matures. Compost tea is made and applied as a protective biofilm on the phylloplane and to deliver plant growth promoting substances.

The Bottom Line

To apply compost topdressing to fairways we purchased a TY-Crop MH-400 for $20,000. This material hauler/topdresser is used for other tasks as well, such as rapid refill of materials while topdressing greens and tees and applying sand in bunkers. The compost we currently use is a 50/50 mix of yard trimming compost and biosolids. Our cost for yard trimming compost is $14.00/cubic yard. For us now, biosolids are freely available (EPA permits are needed). The rate used is approximately 17 yards (7 tons)/acre = 1/8" layer. Total material cost is $119/acre. We offset some costs by reducing our other fertility inputs and decreasing fungicide treatments as part of our IPM program.

All Composts Are Not Created Equal

Understanding the chemistry, biology and science of compost is complicated. Parent material used, how it's managed during composting, and storage can all have a huge effect on the finished product and results. Yet our efforts to understand compost, particularly its microbial benefits, have paid off. Results using composts have been positive and the turf ecology is improving under our growing conditions.

To find out more about the composting practices at North Shore C.C., contact superintendent Dan Dinelli, CGCS, at 847-724-4963, or via e-mail at ddinelli@aol.com.