How to Categorize Organic Materials in Turfgrass Root Zones

By Deying Li

The term "soil organic matter" means different things to people of different fields. In agriculture, it implies high soil fertility and should be maintained against soil deterioration. In environmental science, it is regarded as a sink for carbon dioxide (CO_2), a filter for water, and a buffer to contaminants. In engineering, it may imply a less stable foundation. Perhaps in no other area can organic matter create more controversies and misunderstandings than in the field of turf management.

The term raises many questions, such as what materials are considered to be soil organic matter, how are they distinguished, which are beneficial and what is the optimum amount for turf root zones.

Most importantly, turf managers want to know how to attain an ideal root-zone media for their turf. While many papers have been published on isolated issues of this topic, a view of the whole picture will help turf managers solve the organic puzzle.

Soil organic materials

There are different types of organic materials in a turf root zone, including soil organic matter, soil organic residues and soil biomass. Many turf managers are confused with the terms, mistaking thatch for soil organic matter, for example. As a result, turf managers are often indifferent about organic sources and are unsure about how to maintain high soil fertility and a low level of thatch accumulation in the turf.

The Glossary of Soil Science Terms Committee (GSSTC) of the Soil Science Society of America (SSSA) defines "soil organic matter" as "the organic fraction of the soil exclusive of undecayed plant and animal residues."

Soil organic matter is synonymously used with "humus." Soil organic matter is divided into two subgroups, nonhumic substances and humic substances. Nonhumic substances belong to the known classes of biochemistry, such as amino acids, carbohydrates and fats, while humic substances are of unclear molecular structures with high molecular weights and of brown and other dark colors. Humic substances are further divided into humins, humic acids and fulvic acids in accordance to their solubility in acid and alkali.

The second component of organic material in turf root zones is thatch, defined as "an intermingled organic layer of dead and living shoots, stems and roots that develop between the zone of green vegetation and the soil surface" (Beard, 1980). Turgeon (1979) excluded living tissues in his more academic definition. There are some synonyms for thatch, but most of them are loose or misleading, such as mat.

It is important to note that thatch is classified as organic residues by soil scientists and should not be considered as soil organic matter. Until thatch is decomposed, it will not return any nutrients back to the soil but tie up nutrients. In fact, a heavily thatched turf may not have enough soil organic matter because of the diminished decomposition and mineralization.

The third component of soil organic material, soil biomass, is the collection of living organisms in soil. Soil microbes are of particular importance because they are essential for soil organic matter regeneration and mineralization. It is commonly believed that new sand-based greens are sterile. Research showed that newly constructed greens are colonized rapidly by a large number and wide arrange of microorganisms within the first year regardless of sand, peat and fumigant source.

Effects of soil organic matter on turf

Soil organic matter has many beneficial effects on root-zone media. For instance, it improves and stabilizes the structure of soil-based root zones through aggregation. It also enhances physical properties of both soil-based and sand-based root-zone media by balancing water and air-holding porosity.

Furthermore, it increases the cation exchange capacity (CEC), which acts as a storehouse of nutrients and supplies significant amounts of nitrogen (N), sulfur (S), phosphorus (P) and

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TABLE 1

Chemical and physical properties of organic materials for use in turf

ORGANIC SOURCES	PH	OM (%)	CEC (CMOL$_C$/100G)	EC (DS/M)	C/N RATIO[1]	NUTRIENT RELEASE	MICROBIAL ACTIVITIES[2]	HAZARDOUS RISKS[3]	BULK DENSITY (KG/M^3)	BLENDING HOMOGENEITY WITH SAND	PHYSICAL PROPERTIES FOR SAND MIX
Reed sedge peat I	5.1-7.5	>85	>140	1.0-1.5	23:1	Slow	Low	Low	190	Excellent	Excellent
Sphagnum peat	3-4	>95	100-200	2.0-3.0	47:1	Low	Very low	Low	72-112	Good	Good
Hypnum moss peat	5-7	<80	140	0.7	35:1	Low to moderate	Very low	Low	80-160	Good	Medium
Reed sedge peat II	4-5	30-80	100-150	2.4	40:1	Low	Very low	Low	160-288	Excellent	Excellent
Peat humus	5.0-7.5	<50	1-120		48:1	Moderate	Low	Low	320-641	Excellent	Good
Rice hulls	6.4	72	60	0.95	19-50:1	Low	Moderate to high	Low	500	Medium	poor
Cotton burr compost	5-7.5	38	200	1.7	8-22:1	High	High	Moderate	1,200	Poor	Poor
Composted bark	4-5.5	64	50	2.5	115:1	Low	Moderate	Moderate	400	Poor	Poor
Manure	6-8	4-36	75-100	7.4	12:1	Moderate to high	Very high	Low	700	Poor	Good
Biosolid	6.6-7.2	24	80	2.2-3.5	20-100:1	Moderate	Moderate	High	1,400	Good	Moderate
Recommend range	6.0-7.5	>80	>100	<1	<30:1	Slow	Medium or lower	Low	<500	Good or better	Good or better

1. Carbon-to-nitrogen ratio can be manipulated by adding chemicals. and the result is short-lived.
2. Microbial activities indicate the microbe population (both beneficial and harmful) before turf establishment.
3. Hazardous risks donate potential count.

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other nutrients after mineralization. Finally, soil organic matter ties up toxic ions to decrease its availability to plants and lessen the chance of contaminating ground water.

The optimum amount of organic matter depends on whether the root zone media is sand- or soil-based. Three to 5 percent of organic matter is adequate for sand-based root-zone media. In soil-based root zones, 10 percent of soil organic matter is acceptable.

Under normal management, soil organic matter content reaches a balance at about 4 percent decades after establishment in many golf course putting greens and fairways (Qian and Follett, 2002). Conversely, .5 inch (equivalent to 1 percent by weight) or more of thatch usually causes problems in turf.

Cause, prevention, and mitigation of thatch

More rapid accumulation than decomposition and mineralization of plant residue results in thatch. This is caused by poor soil physical conditions, such as deficient aeration, excessive or inadequate moisture and insufficient interaction among plant residue and soil particles. This prevents the colonization and activity of microbes in the breakdown of the thatch layer.

Arranging traffic away from trouble spots during times of disruptive moisture levels will help to reduce the degree of soil compaction. Often, rearranging rounds of golf is not an option. It is therefore critical to build a sports turf root zone with a medium that is less susceptible to compaction, such as sand or a sand/peat mixture.

Extremely acidic soil (pH of less than 5) or alkali soil (pH more than 8) is unsuitable for the life of microorganisms because most of the beneficial fungi can not survive the high pH, while the useful bacteria can not tolerate low pH. Regardless of species, microorganisms require a favorable total carbon and nitrogen ratio in the soils because they consume certain parts of nitrogen for each part of carbon they digest. Overdoses of nitrogen often stimulate faster shoot growth and thatch accumulation. Frequent use of insecticides and fungicides also kills nontarget soil organisms that are responsible for the breakdown of plant residues.

All turf management practices affect thatch accumulation and decomposition. Starting with a good root-zone medium to prevent thatch is more economical than to mitigate the problem afterward. Many materials have been tested to improve the physical properties of golf green root zones. By the early 1990s, peat has become an irreplaceable component in sand-based root zones and a benchmark for the evaluation of new organic and inorganic soil amendments.

Topdressing should be considered as a continuation of root-zone construction. It is not rare for golf greens and sport fields to rise a few inches over the original root zone as a result of years of topdressing. Since any two layers of material together will have less water conductivity than that of either of the material alone, layering must be avoided by the use of a material that is stable and consistent in property for many years to come.

Sources and characteristics

Peat is abundant and renewable. People extract nearly 100 million cubic meters of peat per year while the earth generates a similar volume naturally. Peat in Canada is growing more than 70 times as fast as it is being harvested. Canada is harvesting less than 1 percent of the peat bogs (Moore, 2001).

Peats are generally not rich in nutrients other than nitrogen. Generally speaking, high organic content, low ash content, uniform fiber sizes, and low-to-medium pHs are the best quality to mix with sand for root-zone construction and topdressing.

Compost is defined as organic residues, or a mixture of organic residues and soil, that have been mixed, piled and moistened, with or without addition of fertilizer and lime, and generally allowed to undergo thermophilic decomposition until the original organic materials have been substantially altered or decomposed. Compost is sometimes called "artificial manure" or "synthetic manure."

Today's compost from municipal waste has a bad reputation because of contamination by heavy metals, plastic film and glass. Some compost may have other chemical residues such as defoliant in cotton burrs and herbicides in other plant materials. Implementing new standards is promising, but the quality of compost still faces serious contamination and hygienic problems because of the difficulties in source separation.

Manure and compost have recently been reported showing disease suppression effects. Most of the tests used immature composts and compared with unfertilized control, which makes comparison of soil fertility level unavailable. However, the information or soil nitrogen levels is needed because disease severity is affected by the N-level in the soil.

Stockwell, et al. (1994) tested 104 strains of actinomycetes isolated from different composts and found that no strains give significant control of pythium root rot or brown patch, and only five strains showed control of dollar spot. Highly saline composts enhance pythium and phytophthora diseases. Composts prepared from municipal sewage have a low carbon-to-nitrogen ratio and release large amount of N which may enhance fusarium wilt.

Quality compost should be high in organic matter content, free from heavy metal and chemical contamination, free of disease agents and low in silt and clay fraction. Since most of the composts are used as alternatives for fertilizers, the nutrient release of the compost should be evaluated before its use. Fast release of surplus N can cause turfgrass burn.

Prices of the organic materials are not the topic of this discussion. However, golf course and sports turf facilities are often targeted as big dollar markets by many companies. Some basic characteristics of organic materials are listed in Table 1 to help turf managers choose a suitable product.

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REFERENCES

Beard, J.B. (ed.) 1980. "Glossary of turfgrass terms." pp. 507-515. *In*: J.B.Beard (ed.) *Proc. 3rd International Turfgrass Research Conference*, Munich, Germany. 11-12 July 1977. Int. Turfgrass Soc., and ASA, CSSA, and SSSA, Madison, Wis.

Moore, J.F. 2001. "Where does peat come from anyway?" USGA Construction Education Program. http://www.usga.green/coned/misc/where_does_peat.html

Qian, Y. and R.F.Follett. 2002. "Assessing soil carbon sequestration in turfgrass systems using long-term soil testing data." *Agron. J.* 94:930-935.

Stockwell, C.A., E.B.Nelson and C.M.Craft. 1994. "Biological control of *Pythium graminicola* and other soil-borne pathogens of turfgrass with actinomycetes from composts." *Phytopathology.* 84(10):1113.

Turgeon, A.J. 1979. "Influence of thatch on soil is both positive and negative." *Weeds, Tree and Turf.* 18:48-50