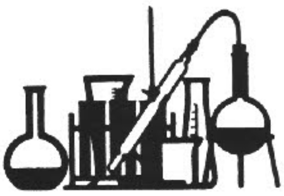

ORGANIC MATTER IN TURF

By Dr. Wayne R. Kussow

Whether we are constructing a sand-based green, preparing a topdressing mix, trying to establish organically grown sod, fighting thatch accumulation or trying to destroy black layer, we're all concerned about the same thing — organic matter. Understanding the properties of organic matter is one of the keys to better turf production and management.

Properties of Organic Matter

Several properties of peat, muck and thatch are presented in Table 1. In the turf world, many people fail to distinguish between peat and muck. Peat contains readily identifiable plant fibers, is considerably less decomposed than muck, and is often physically similar to thatch. Muck is so highly decomposed that no plant remains are identifiable. It is dark brown to black in color and is essentially the same as what we know as humus in soil.

Table 1. Properties of three general types of organic matter.

	Type of organic matter		
Property	**Peat**	**Muck**	**Thatch**
Water holding capacity, %	100-400	90-150	30-60
1/3 Available water, %	10-80	20-60	5-10
Bulk density, g/cc	0.05-0.15	0.17-0.52	0.10-0.25
Ash content, %	1-50	10-60	15-25
Carbon/nitrogen ratio	15-40	13-20	30-60
pH	3.1-7.6	4.5-8.0	5.6-6.5
Cation exchange capacity	70-140	120-210	40-100
Biological stability, half-life in years	1-3	4-5	1.5-2.5

The relevance of each of the properties shown in Table 1 is as follows:

1. Water holding capacity is the amount by weight of water held by the material after having been saturated and then allowed to drain until no more water drains out. The significance of the values shown in Table 1 lies in the fact that mineral soil water holding capacities range from about 10% for sand to 35% for clay soil.
2. One-third available water is the percentage of water held by the material that plants can readily use. When more than one-third of available water is used up, plants begin to suffer from moisture stress on warm sunny days.
3. Bulk density is the dry weight of the material that occupies a cube whose dimensions are one centimeter (0.39 inch) on each side. Bulk densities of peat, muck and thatch, being in the range of 0.05 to 0.52 g/cc, are much less dense than mineral soils and do not inhibit plant root development as can a soil with a bulk density of 1.6 g/cc or more.
4. Ash content is the percent by weight of inorganic material that remains when all of the organic carbon is burned off. Ash content signifies the degree of contamination of the organic matter with mineral soil particles.
5. The carbon/nitrogen ratio of biological decomposition. Organic materials with carbon/nitrogen ratios greater than 30 will not readily decompose unless microorganisms can obtain nitrogen from some other source such as the soil or fertilizer.
6. pH reflects the acidity in the organic matter. Microbial activity is low in highly acidic material and the cation exchange capacity of organic matter is entirely pH dependent. The higher the pH, the higher the cation exchange capacity of organic matter.
7. Cation exchange capacity refers to the quantities of calcium, magnesium and potassium ions that loosely bond to the organic matter in a manner that greatly reduces their leaching rate but also makes them available to plants.
8. Biological stability, expressed in terms of half-life, refers to how many years it takes under optimum growth conditions for microorganisms to decompose one-half of the organic matter present at any given time.

To see how these various properties of organic matter relate to turf and its management, let's examine several specific instances where organic matter is of major concern.

Sand-based Greens

The USGA specification sand-based greens and sand topdressing mixes rely upon organic matter in several different ways. Organic matter is needed to:

1. Increase moisture holding capacity.
2. Reduce bulk density.
3. Provide cation exchange capacity.

Thus, we need to look for material that has these properties. At first glance at Table 1, we might decide that some type of peat is the material of choice. However, we also want a material that has as high a biological stability as possible and our attention then turns to muck. Among the mucks, we would then seek out one that has a pH near 7.0 to give not only a favorable pH, but also high cation exchange capacity. Finally, we want the lowest ash content possible. High ash peats and mucks contain a lot of clay-sized particles that, over time, clog up pores in the greens mix, thereby reducing water infiltration and impeding drainage. Perhaps this is one of several factors leading to black layer formation?

With regard to the cation exchange properties of peat or muck, there is one thing that is well to keep in mind. The negatively charged sites on organic matter that attract and hold cations in an exchangeable form have a strong preference for the divalent cations Ca^{2+} and Mg^{2+}. This means that a monovalent cation such as potassium (K^+) remains largely in solution and leaches very readily from sand-peat mixtures. The problem is particularly acute when the irrigation water used is "hard"; i.e. contains large amounts of Ca^{2+} and Mg^{2+} ions.

Potassium leaching in sand-peat greens is one of the strongest arguments I know of for using an 8:1:1 sand-peat-silt loam soil mix for greens. The silt loam soil possess cation exchange sites that do not show the strong preference of organic sites for divalent cations. Hence, potassium leaching is considerably less from an 8:1:1 mix than an 8:2 sand-peat mix. Extensive use of the 8:2 mix is what has led to the idea that nitrogen and potassium have to be annually applied in nearly equal amounts to USGA greens.

Organic Sod

Sod is traditionally grown on organic soil and on muck in particular for numerous reasons, two of which are the relatively low weight of the rolls of sod and less tendency to tear during handling. However, some concerns or questions arise regarding organic sod when it comes to the time of rooting and management during the period of establishment. When it occurs, slow rooting is a product of two things. One, is the fact the roots penetrating soil exert a backward force that has to be counteracted by weight from above and root hairs anchored into the soil beneath the sod. Organic sod, because of its relatively low bulk density, can be at a disadvantage in comparison to sod established on mineral soil. Secondly, laying organic sod over a mineral soil creates a textural discontinuity. Water moves faster through the organic layer than the mineral soil below. The result can be accumulation of excessive moisture at the sod-soil interface. This is not a very hospitable environment for new root growth and favors pathogen growth and development.

Recent research has shown that organic sod roots as rapidly and extensively as mineral sod as long as both are being laid over properly prepared mineral soil. Neither type of sod performs well when laid over compacted, structureless mineral soil or a scanty two inches of topsoil overlying a dense subsoil that has been pulverized and scraped to provide a firm, smooth base. Both types of sod will root rapidly if laid on loose, friable and well granulated topsoil that drains well into the subsoil below. Irrigation scheduling and rate then become important considerations. They need to be such that sufficient time occurs between irrigations for water to infiltrate into the mineral soil beneath the sod layer.

Another management concern with organic sod is how much nitrogen is being released from the organic layer. This is a legitimate concern because, during the establishment period, excessive N stimulates grass top growth to the detriment of root growth and places a high demand for water on a very limited root system. Studies in Wisconsin on the rate of release of nitrogen from muck soils provide some basis for answering this question. For 9 muck soils, the average amount of N released per one-inch depth of soil was 0.23 lb N/1000 ft^2 in the first month. In the next two succeeding months, the N released amounted to 0.36 lb/1000 ft^2, and between months 3 and 6, an additional 0.37 lb N was released. Hence, in a 6-month period, the average total amount of N released from a 1-inch layer of muck soil was 0.96 lb/1000 ft^2. This is a significant amount of N that should not be ignored when fertilizing newly sodded areas.

Thatch

The final type of organic matter to be considered here is thatch. As shown in Table 1, even under optimal conditions, biological decomposition of thatch occurs at about the same rate as for peat. The biological stability of thatch and, hence, its tendency to accumulate, arises for several reasons. One is the low available water content of thatch that limits microbial activity. This is a major reason why topdressing and/or core aeration are fairly effective thatch control measures. Mixing soil in with the thatch increases moisture retention and permits more microbial activity.

Another reason why thatch decomposes slowly is its relatively high carbon/nitrogen ratio (Table 1). Rapid microbial decomposition of thatch requires an outside source of nitrogen. One possible means for meeting this need is to incorporate a slow release N fertilizer into the thatch along with topdressing mix or soil brought up during core aeration.

Research results shown in Table 2 provide some insight into the role that cultural practices can play in thatch control. The first thing to note is the relatively small changes in thatch depth that occurred over the seven year period. This points up the fact that in turf areas prone to thatch accumulation, cultural practices such as those listed in Table 2 will seldom resolve the problem without assistance in the form of frequent and light dethatching of the turf.

As for the effects of various cultural practices, combinations are the rule rather than the exception. The objective one is attempting to achieve to prcvide the best environment possible for biological decomposition of the thatch layer. This means incorporating some soil to improve the moisture status of the layer, adding nitrogen to off-set the high carbon/nitrogen ratio of the thatch and providing an optimum pH of near 7.0.

Note particularly in Table 2 the effect of a wetting agent on thatch accumulation. This is one of the enigmas in turf management. Thatchiness often leads to localized dry spots where the manager's normal response is to apply a wetting agent. This gets water to penetrate the thatch layer, but leaves it drier than normal. The result is more thatch, not less. This can quickly lead to an unending cycle of dry spots-wetting agents-dethatching that can only be broken with regular core aeration and incorporation of core material into the thatch layer or periodic topdressing with a mix of the same or very nearly the same composition as the soil beneath the thatch layer.

Table 2

	Thatch	
Treatment	**Depth**	**Change**
	Inches	
1. None	0.35	—
2. Spoon aerifying	0.35	0%
3. Spike aerifying	0.31	-11%
4. Wetting agent	0.44	+26%
5. Annual liming	0.28	-20%
6. Slow release N	0.43	+23%
7. Topdressing	0.28	-20%
8. 5 + 6 + 7	0.30	-14%

Adapted from Engel and Alderfer (1967).

In summary, organic matter plays numerous roles in turf production and management. Some are desirable, some are not. In either instance, knowing the properties of organic matter and the factors controlling its persistence in turf provides the basis for making wise management decisions.