INFLUENCE OF ORGANIC DYNAMICS ON CREEPING BENTGRASS / PA GREENS

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A common story – the green rootzone components were selected based on good soil physical laboratory analyses; the rootzone mix was properly blended; construction and grow-in were conducted properly. But, starting at 2 years after establishment root depth declines and as time passes water infiltration decreases and summer stresses seem to occur more frequently. Club members question why problems can still occur after using the USGA specifications for golf green construction – the most comprehensive and scientific based construction method.

The answer is – that the rootzone profile has changed over time. The most consistent and dramatic change that occurs on high sand golf greens (or athletic fields) after establishment is accumulation of organic matter (O.M.) within the surface 1.25 inch (32 mm; depth used by author in research studies) to above the 1 to 3% by weight O.M. used in initial mixes. This "layer" no longer has the same soil physical properties as the original rootzone mix. Thus, it is not a problem of specifications but one of management.

Research has consistently demonstrated that as O.M. content in a sand mix increases to above 3 to 4% by weight the percent of larger soil pores (macropores, aeration pores) of >0.12 mm diameter between sand particles decreases due to plugging by O.M. *As macropores become sealed or plugged by the O.M., three primary problems occur:*

(a) Oxygen (O_2) diffusion into the rootzone declines. Oxygen is essential for turfgrass roots to grow and function in water/nutrient uptake, as well as, maintenance of an aerobic microorganism population.

(b) Water infiltration rate decreases, which can lead to a saturated surface after rainfall.

(c) Moisture content increases after free water has drained in response to the higher O.M. content and higher percent of micropores (capillary, moisture retention pores).

These three alterations in soil physical properties can contribute to numerous *secondary turfgrass management problems* such as disease, soft surfaces, poor root growth, black layer, and more frequent direct/indirect high temperature injury. Long term management should focus on correcting primary problems (which is the focus of this article) while dealing with secondary problems as they occur; but, alleviating the primary problems greatly reduces the secondary ones.

Perhaps the easiest way to understand the diverse detrimental effects of O.M. dynamics is to consider certain field problem situations. In each of these situations the initial (primary) problem is excessive O.M. content <u>or</u> changes in the nature (characteristics) of the O.M leading to lack of macropores. However, the "problem" that people see are the secondary problems arising from these conditions.

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Field Situations

Surface zone organic matter is proposed by the author to become a problem under two field situations. ***First*** ***is when the total O.M. accumulation becomes excessive*** and causes most of the macropores between sand particles to become filled, thereby, decreasing infiltration, percolation, and aeration. This "layer" problem differs from other possible layers in greens since it is a "living layer" composed of considerable O.M. from the living plant. Approximately 5.0% O.M. (wt.) is sufficient to significantly seal or plug most sands when the O.M. is added as an amendment. However, the value appears to be as high as 10 to 14% if much of the O.M. is present as live roots. Roots have a "structure" of long cylinders with space between roots that apparently allow water infiltration and gas exchange to occur at reduced but adequate rates even at these high percent O.M. levels (author's current research observations).

This type of O.M. problem is most likely to occur in cool periods of the year when root growth is high – including lateral, adventitious roots near the surface; thereby, leading to reduced water infiltration and low aeration after several weeks of cool weather. At Atlanta, Georgia which is near the southern limit for use of creeping bentgrass, the lowest O_2 levels and infiltration rates occur in the winter months. This can lead to a decrease in root development during the late winter and spring. During the winter and spring, there often isn't any evidence of low soil O_2 stress based on shoot observations and even roots may appear healthy. But, a reduced rate of root growth ultimately means fewer roots going into the summer. Turf managers may observe the effects of a reduced water infiltration rate during cool periods in the form of standing water on low areas, soggy surface conditions after rains, and greater runoff on sloped areas.

However, continued accumulation of total O.M. (i.e., live roots plus non-living O.M.) will eventually seal surface pores regardless of the season. Cool, temperate climates are ideal for this type of organic matter accumulation, such as the Northern United States, Eastern Canada, B.C. Canada, New Zealand, and Northern Europe. The prolonged periods of temperatures above 32° F (turf continues to grow) but below 55° F (soil microorganism activity for decomposition is low) leads to a steady build up of O.M. *In these climates this is the primary management problem confronting turf managers of high sand rootzones* – rapid O.M. accumulation not only in the surface but deeper in the profile.

Another example of excessive O.M. content buildup at the surface is when the primary matrix is no longer sand but O.M. This occurs when insufficient sand topdressing is applied to keep up with O.M. additions by the turfgrass plant. Once the individual sand particles become separated by O.M., the surface no longer resists compacting forces but is prone to a layer forming at the thatch soil interface that is composed of compacted O.M. with a slick, moist appearance. Sometimes during grow-in, thatch accumulates faster than sand is topdressed onto the turf. Thatch which has considerable sand uniformity integrated throughout the O.M. and at high enough content becomes a "Mat". A mat is capable of producing a good quality turf and firm putting surface because sand is the primary matrix and provides a firm, compaction-resistant surface. In contrast, a true thatch at the surface can compact and exhibit the slick, black mini-layer (i.e., 0.25 to 0.50 inch) at the bottom of the thatch where the thatch-soil interface occurs.

This particular problem is most often observed after grow-in but it can arise on any green when topdressing is not adequate. The actual O.M. content in the thatch zone may be greater than 20% by weight but not necessarily at this high percentage over the whole 1.25 inch surface layer. Also, application of infrequent but heavy topdressing to greens can create such mini layers of high O.M. content because the sand doesn't integrate into the thatch accumulated since the last topdressing. These mini layers of high O.M. are prone to compaction which decreases the macropores that would normally be present.

A <u>second</u> situation that causes problems is when the "nature" of the O.M. changes from structured O.M. (mainly as live roots) into a gel-like consistency. This is most likely to occur on a cool-season grass during hot, humid weather that induces rapid root death. Root dieback/death occurs every summer to some extent, but microorganisms can sufficiently breakdown the fresh O.M. to prevent excessive sealing. Under unusually hot, humid weather for 1 or 2 weeks or for a prolonged period, root death occurs more rapidly and can induce low infiltration and low aeration (the fresh dead roots holds more water and are gel-like so it seals macropores) by altering the nature of the O.M. *This response is considered by many to be the number one cause of "summer bentgrass decline" (SBD) under these weather conditions.*

It is not the lack of roots from root dieback that is the problem, but the creation of an excessively moist layer with very low O_2 during hot weather in response to the rapid root dieback. The remaining live roots cannot obtain enough water uptake for transpirational cooling because of the low O_2. This is the same situation that occurs for wet wilt but without standing water. Low soil O_2 in the surface layer where the remaining live roots are present leads to reduced water uptake, stomatal closure, and direct high temperature kill. This is usually evident by yellowing of the turf and death over a 1 to 3 day period of hot, humid weather.

The higher the O.M. content is above 3% by weight the more likely a massive root dieback from hot, humid weather will cause a rapid O_2 stress and plant death. However, even relatively low O.M. contents of 3 to 5% seem to be sufficient to enhance SBD as the gel-like material from recently dead roots retain considerable water, and are very effective in sealing the surface pores in this state.

Cool-season turfgrass used on golf greens are more susceptible to each of these field problem situations than warm-season grasses because:

(a) Cool-season turfgrasses are more sensitive to high temperature summer stresses.

(b) Adventitious surface root development induced by low O_2 and contributing to a rapid increase in surface O.M. content appears to be more prevalent on cool-season grasses.

(c) Climatic conditions favoring O.M. accumulation of prolonged temperatures $<55^{\circ}$ F but with an actively growing grass occurs in cool-season zones. Warm season grasses often have a longer growing season for greater O.M. production but the high temperatures greatly increase O.M. decomposition.

Still, under the right conditions, low soil O_2 / low water infiltration / high surface moisture content can be detrimental to warm-season grasses, and impact over-seeding and spring dieback. Probably the most prevalent low soil O_2 injury on bermudagrass greens is not the rapid decline in turf quality as experienced by bentgrass in SBD but a prolonged lack of a viable root system.

Culture approaches to these two organic matter related problems include:

- Cultivation
- Topdressing
- Grass selection
- Removal of excess moisture
- Forced air addition
- Surface pH control
- Cultural practices to treat secondary and associated problems