Aerification and Soil Physical Properties

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Aerification is promoted as a useful practice to improve soil conditions for grass growth on playing surfaces, such as golf greens and football fields, especially where compaction is a problem. Compaction can be an acute problem on playing surfaces that have been developed in natural soils that originally had medium- or fine-textured surfaces. Aerification systems are designed to create large (½" wide x 2½" deep) cylindrical void or pore spaces in the soil surface, either by removal of a "plug" of soil or more traditionally by spiking the soil. Both aerification systems will clearly result in considerable modification of soil physical properties, such as their structure and porosity, which should ideally optimize factors important for grass root growth such as soil water and air movement and storage and soil temperature.

Questions concerning aerification, which are of obvious interest to individuals in turfgrass management, include the following:

- How often and when should we aerify?
- Which aerification system is the most suitable?
- What are the long-term consequences of extensive aerification on the physical condition of the soil and grass growth?
- What alternative management strategies and practices are available or could be developed to improve the physical condition of the soil to promote optimum grass growth?

Answers to these questions will clearly vary for different playing areas and underlying soils and between individuals, but we believe that much of the guesswork and trial and error can be eliminated by the application of established scientific principles and carefully conducted research involving both turfgrass researchers and practitioners. We conducted a pilot study at the Riverside Golf Club, Janesville, Wis. to evaluate the suitability for turfgrass research of various procedures for determining soil physical properties that we have found to be successful in conducting our agronomic research. A brief discussion of some of our findings is presented below.

A turfgrass sampler was used to take soil samples from greens which had been recently aerified with a device that removes cylindrical plugs from the soil surface. These samples were then impregnated or stabilized with an epoxy resin to make them suitable for cutting, grinding and polishing. The purpose of this was to create ultra-thin sections or slices of soil that can be examined in detail under a microscope. Examination of the slices provided direct information about changes in the soil physical condition and root behavior as a result of aerification. Figures 1-3 illustrate at various magnifications some of the findings from the thin sections.

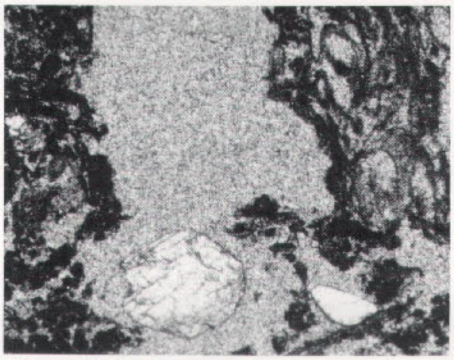

Figure 1. Fresh aeration void (light color, middle of photo) containing a large sand grain that had been topdressed onto the surface and subsequently transported to the bottom of the void. The soil material (dark color, right and left side of photo, surrounding void) shows few signs of compaction as a result of aerification (Magnification x20).

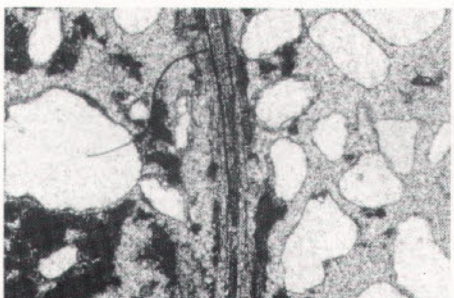

Figure 2. Aeration void filled by sand grains (white) occupies the right side of the photo, running down the middle of the photo is a grass root, and to the left of the root is largely the original soil (magnification x50).

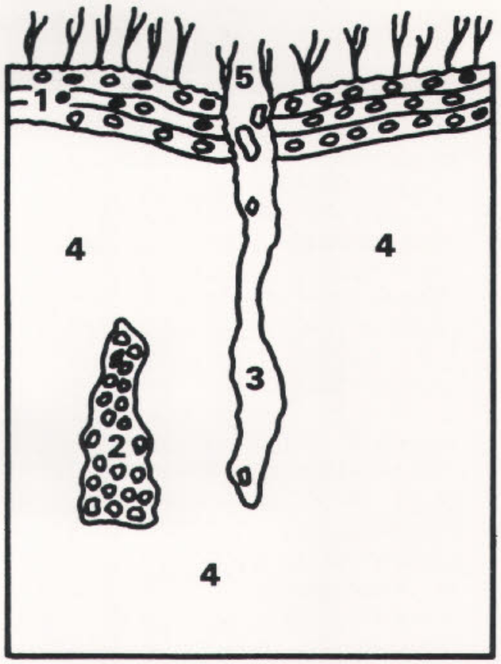

Figure 3. Diagrammatic representation of thin section (full scale) illustrating 1) topdressed surface layer consisting of layers of sand grains and decaying grass root mats; 2) aeration void filled with sand grains and disconnected from surface; 3) fresh aeration void, open to surface but infilling with sand grains; 4) unaerified soil; and 5) characteristic micro-depression surrounding fresh aeration void.

In the samples examined, no appreciable compaction of the void walls was observed. However, soils aerified by spiking (without plug removal) were not examined in the pilot study, but may well produce quite different microenvironments for root growth because this aerification procedure involves soil compression or compaction rather than soil removal to create void spaces.

It was observed that the most extensive root growth occurred along the junction between the voids (filled and unfilled) and the unaerated soil. This observation provides clues for defining and ultimately creating the optimum physical environment for root growth in these soils. It was also observed that many aeration voids were no longer directly connected to the surface and were filled with sand grains which had originally been added to the surface as a topdressing (see Fig. 3). This would suggest that prolonged aerification and topdressing would result in major changes in the soil's physical environment over time and presumably would require appropriate modifications in management practice.

Soil thin sections provide a useful means for deciphering, documenting and even predicting changes in soil physical condition and root behavior over time as a result of aerification. However, other measurement techniques are necessary to gain a more complete appreciation of how aerification affects the physical environment of grass roots. At Janesville, we also used a soil penetrometer to measure changes with depth in soil resistance to a directly applied force. This technique was especially useful for detecting zones of compaction at various depths in the soil. Field observations showed a good correlation between reduced root growth and compaction. Compacted zones were detected below the 3" zone of aerification on some greens, which suggests that in some situations occasional subsoiling may be desirable to alleviate the problem. Equipment is available that is designed to loosen compacted subsurface layers while leaving the soil surface largely undisturbed. This equipment has been used in the agronomic setting for pasture renovation and reduced tillage farming.

The Janesville pilot study demonstrated the potential usefulness of both the soil penetrometer and microscopic examination of soil thin sections as techniques for evaluation of aerification. Soil physical properties, such as air and water permeability and particle and pore size distribution not evaluated in the Janesville study, would be essential to provide a more complete appraisal of the soil physical environment. Extensive studies at various locations would be necessary to answer the questions raised earlier in this article, and would not be limited to evaluation of soil physical parameters but would also include a variety of management variables and estimation of plant growth parameters.

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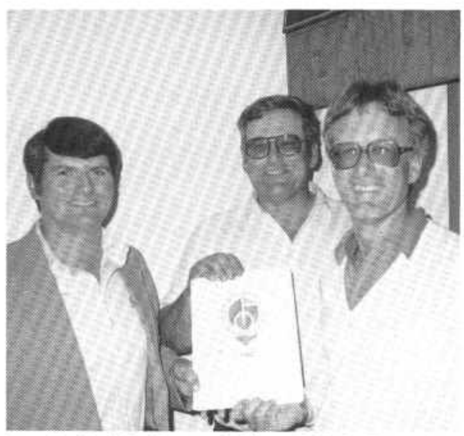

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