How much water is getting to your turf's roots? Water infiltration is a key to healthier turf.

by Don Taylor and C. Frank Williams

- Water infiltration rate is the rate at which water enters the soil. It is critically important in managing turf.

The water infiltration rate determines how much water from a storm actually gets into the soil, and how much runs off the surface. It determines the rate at which irrigation water can be added, and the length of time irrigation can be continued before water starts to pond and run off.

Due to soil compaction, low water infiltration rates are common on golf greens, athletic fields and some lawns. In fact, most turf areas probably suffer from one or more of the following problems associated with low infiltration rates:

1. Lowered irrigation efficiency;
2. Excessive surface water puddling;
3. Poor playing conditions following rainfall; and
4. Turf damage from surface water ponding.

Many factors determine the water infiltration rate, including soil type, soil compaction and the presence of thatch or other layers at the surface.

Soil type—Water moves through the pores between soil particles. Generally, larger soil particles result in larger pores; thus, sandy soils with relatively large particles usually have higher infiltration rates than do finer-textured soils such as loams, silt loams and clay loams.

Several factors must be considered in applying this generalization to turf sites:

1. Compacted, sandy soils can have very low infiltration rates. We have measured rates below 0.1 inches/hour on golf greens modified to have 70 to 80 percent sand by weight.
2. Mixing small amounts of sand into fine-textured soil will usually not improve infiltration rates. Research has shown that sand contents must be very high—around 85 percent sand or higher—in soil mixtures to maintain high infiltration rates.
3. Finer-textured soils which are well-aggregated can have reasonably high infiltration rates if the soil structure or aggregation can be preserved. Aggregation of soils high in clay content is stronger and more easily preserved than soils high in silt content. However, soil structure near the surface of any type of soil will be destroyed if subjected to intensive vehicular or foot traffic.

The key is to preserve as much soil structure as possible, regardless of soil type. This can be done by:

1. Keeping vehicular traffic to a minimum and preserving as much soil structure as possible before turf establishment.
2. Limiting unnecessary traffic on turf, especially when the soil is wet.
3. Maintaining conditions conducive to vigorous root growth, earthworm and micro-organism activity through proper watering, fertilization and aeration practices, and prudent pesticide use.

Soil compaction—The majority of problems with low infiltration rates on turf areas probably result from soil that is compacted before turf establishment. Landscaped sites are often severely compacted inadvertently through construction vehicle traffic. Sometimes the soil is excessively compacted on purpose to establish a smooth, stable surface for sodding.

This type of soil compaction simply must be improved by deep plowing before establishing turf. After establishing turf, options for relieving soil compaction are severely limited.

FIGURE 1
THE WATER INFILTRATION CURVE

Fungicides for pythium control, page 29
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Preventing the leaching process, page 30

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ELSEWHERE
Soil compaction following turf establishment can—and frequently does—occur on golf turf, athletic fields and other heavily used turf areas from concentrated foot traffic. The most common method of alleviating soil compaction on an established turf is through aerification.

Typical aerifiers only go to a limited depth (three to four inches, at most), and disturb a small percentage of the surface. A typical athletic field aerator with 3/4-inch tines taking cores on six-inch centers disturbs only 1.2 percent of the surface with a single pass. A typical golf green aerator with 1/2-inch tines taking cores on two-inch centers disturbs 4.9 percent of the surface. Thus, with most aerifiers, several passes over the turf when soil moisture conditions favor deep tine penetration are required.

The new deep-tine aerifiers can open holes to a depth of 12 inches or more. New water-injection machines can create openings in the soil using water drops under high pressure.

### Thatch

— The presence of thatch at the soil surface has interesting influences on water infiltration rates.

As long as the thatch layer is relatively un-decomposed, water can flow readily through it, if it is moist. If the thatch is dry, however, it becomes hydrophobic and repels water.

Fig. 1 shows the general response of infiltration rate as time progresses through a storm or irrigation cycle. In normal soils, infiltration rate starts high and decreases as the soil becomes increasingly wet. A dry thatch at the surface causes the initial infiltration rate to be low. Infiltration rate increases as the thatch moistens up.

Maintaining moist conditions in the thatch layer, either through syringing or by a short moistening irrigation prior to a storm or a regular watering, may improve water infiltration into the soil.

Other types of surface layers can severely impact water infiltration rate.

A layer of peat on fine soil or peat, once compacted, can severely limit water infiltration. The resulting infiltration curve is represented by the bottom curve in Fig. 1.

Windy soil, particularly silt-sized particles, can plug the pores at the surface of a turf soil and reduce infiltration rates.

Algae growth can create a limiting layer at the soil surface.

Intensive aerification can help break up surface layers regardless of their source, and reduce their impact on water infiltration rates.

Rather than actually measuring infiltration rates (see accompanying article), it seems preferable for turf managers to evaluate the symptoms associated with low water infiltration rates.

One symptom is standing water on the soil surface. Perhaps the simplest method of determining if low infiltration rates are a problem for your turf conditions is to carefully inspect the area during normal irrigation cycles and during substantial storms. If any water collects at the surface during irrigation or if excessive amounts collect during storms typical of your area, then water infiltration rates are too low.

Other symptoms which may be useful in assessing water infiltration rates are evidences of soil compaction—such as hard soil or restricted root systems—shallow depths of soil wetting after irrigation, or distinct soil layering in the rootzone.

What can be done about low water infil-

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**RING SIZES SHOW DIFFERENT RESULTS**

On one golf green where sand topdressing had resulted in several inches of sand over the original gravelly loam topsoil, infiltration rates measured with the small rings averaged 2.0 inches/hour, while the infiltration rate measured with the large rings averaged 0.6 inches/hour. Our opinion the water in the soil was flowing horizontally in the sand layer rather than vertically into the gravelly loam layer.

At one golf green, which had been constructed of 100 percent sand, and where we expected fairly uniform conditions, we measured rates varying from 2.6 to 7.9 inches/hour using the large rings.

— The authors

**Measuring infiltration**

Though many sophisticated methods are used to measure the water infiltration into soil, the only method suitable for routine use by turf managers is to drive a cylinder of two concentric cylinders into the soil. After maintaining a pond of water inside the cylinders for an hour or so, the infiltration rate can be determined by measuring how fast the ponded water in the inner ring drops.

If, for example, the water level drops by 0.2 inches in 15 minutes, the infiltration rate is 0.2 inches divided by 0.25 hours or 0.8 inches per hour.

Typical rings used in agriculture are one foot in diameter or larger. The double ring consists of an inner ring one foot in diameter and an outer ring 20 inches in diameter. Infiltration rings this large are cumbersome and require considerable quantities of water if the infiltration rate is high.

Smaller rings can easily be made. Rings made from a six-inch and an eight-inch turf repairer were used in an experiment to determine their usefulness in assessing water infiltration rates on turf areas. The results were not particularly encouraging and indicated two cautions with using ponded water in rings to measure infiltration rates:

1) Though small rings are easy to use, their results do not always agree with results from large rings. We found this to be particularly true where distinct layers were known to exist in the soil. Measurements from smaller rings are more affected by lateral or horizontal flow than larger rings, and the smaller the ring, the greater the over-estimation of vertical infiltration rate.

2) Infiltration rates into the soil can vary dramatically, even within a small area. Consequently, measurements at several locations on the turf site are essential. A single infiltration measurement to characterize a golf green, athletic field or other turf site may lead to gross errors. Even with several measurements, our opinion is that using water ponded in rings will do no better than give an estimate of infiltration conditions.

— Taylor, Williams
ination rates in turf areas? Most impor-
tantly, we need to change our perception
about how the soil is treated prior to turf
establishment. If everything possible were
done to preserve soil structure and mini-
mize soil compaction prior to turf estab-
lishment, most of our problems with low
infiltration rates would not occur.
Where turf is already present and infil-
tration rates are low, aerification—and
plenty of it—should be the first corrective
measure. Once over is not enough; several
passes are necessary. Often, adequate turf
conditions can be maintained despite com-
pacted soil and low infiltration rates with
frequent and intensive aerification.
If regular aerification is insufficient,
then more extensive treatments such as
deep tine aerification or reconstruction
may be required.

Fungicides for pythium on golf course
fairways

- In a test conducted at Penn State
University, nine of 15 fungicides tested on
pythium blight were providing excellent
control eight days after application. By 16
days after application, eight, including
three Banol/Subdue mixtures, were still
providing control.

- One fungicide application was made on
July 16th. One day after application, the
plots were inoculated with Pythium
aphanideratum. They were again inocu-
lated eight days after application.

- The tests were conducted at the
Valentine Turfgrass Research Center on
perennial ryegrass maintained under golf
course fairway conditions, which simulat-
ed high humidity.

- The tests were conducted by P.L.
Sanders and M.D. Soika, and reported in
“The Keynoter,” the publication of the
Pennsylvania Turfgrass Council.

See adjacent chart for complete test
results.

### PYTHIUM BLIGHT CONTROL, POST-TREATMENT RESULTS

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Formulation</th>
<th>Rate/1000 sq ft</th>
<th>Pythium blight severity&lt;sup&gt;1&lt;/sup&gt; 8 days post-treatment</th>
<th>Pythium blight severity&lt;sup&gt;1&lt;/sup&gt; 16 days post-treatment</th>
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<tbody>
<tr>
<td>FCI 6444</td>
<td>50W</td>
<td>1.47 oz</td>
<td>8.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.0&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>RO 43-2664</td>
<td>24%</td>
<td>0.32 fl oz</td>
<td>7.0&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>9.2&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td>FCI 6444</td>
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<td>2.9 oz</td>
<td>7.0&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>8.3&lt;sup&gt;ab&lt;/sup&gt;</td>
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<tr>
<td>Check</td>
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<td>N/A</td>
<td>6.3&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>8.2&lt;sup&gt;ab&lt;/sup&gt;</td>
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<tr>
<td>RO 43-2664</td>
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<td>0.65 fl oz</td>
<td>4.8&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>9.0&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td>RO 43-2664</td>
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<td>1.3 fl oz</td>
<td>3.7&lt;sup&gt;cd&lt;/sup&gt;</td>
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<tr>
<td>S 3116</td>
<td>G</td>
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<td>3.2&lt;sup&gt;cd&lt;/sup&gt;</td>
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<tr>
<td>+ Koban</td>
<td>30W</td>
<td>4.0 oz</td>
<td>1.2&lt;sup&gt;de&lt;/sup&gt;</td>
<td>3.0&lt;sup&gt;cd&lt;/sup&gt;</td>
</tr>
<tr>
<td>Aliette</td>
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<td>4.0 oz</td>
<td>0.7&lt;sup&gt;e&lt;/sup&gt;</td>
<td>2.8&lt;sup&gt;cd&lt;/sup&gt;</td>
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<tr>
<td>Subdue 2E</td>
<td>4.0 oz</td>
<td>1.0 oz</td>
<td>0.7&lt;sup&gt;e&lt;/sup&gt;</td>
<td>3.3&lt;sup&gt;c&lt;/sup&gt;</td>
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<tr>
<td>Banol 6S</td>
<td>0.7 fl oz</td>
<td>0.5 fl oz</td>
<td>0.7&lt;sup&gt;e&lt;/sup&gt;</td>
<td>1.5&lt;sup&gt;cd&lt;/sup&gt;</td>
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<tr>
<td>+ Subdue 2E</td>
<td>6S</td>
<td>1.3 fl oz</td>
<td>0.7&lt;sup&gt;e&lt;/sup&gt;</td>
<td>1.3&lt;sup&gt;d&lt;/sup&gt;</td>
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<tr>
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<td>1.3 fl oz</td>
<td>0.5&lt;sup&gt;e&lt;/sup&gt;</td>
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<td>1.0 fl oz</td>
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<td>3.0&lt;sup&gt;cd&lt;/sup&gt;</td>
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</tbody>
</table>

<sup>1</sup> 0-10 visual rating scale, where 0 = no blight present, 1 = 10% of plot blighted, and 10 = 100% of plot blighted; mean of three replications.

<sup>2</sup> Within columns, means followed by the same letter are not statistically different, using Waller-Duncan K-ratio t test.

Source: P.L. Sanders & M.D. Soika, Penn State Univ.

### ANT CONTROL RESULTS

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate (lb Al/acre)</th>
<th>Mean number of ant mounds per 144 ft&lt;sup&gt;2&lt;/sup&gt; plot&lt;sup&gt;*&lt;/sup&gt;</th>
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<tr>
<td>019537</td>
<td>2.5 lb/100 ft&lt;sup&gt;2&lt;/sup&gt;</td>
<td>20.7 a 18.0 ab 6.8 bc 8.0 bc 8.5 ab 7.5 ab</td>
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<tr>
<td>Pageant DF</td>
<td>1.0</td>
<td>24.3 a 21.3 a 10.0 ab 19.7 a 18.0 a 13.2 a</td>
</tr>
<tr>
<td>XRM-5184</td>
<td>1.0</td>
<td>24.3 a 10.2 bc 4.7 bc 4.2 bc 8.5 ab 7.0 ab</td>
</tr>
<tr>
<td>Dursban ME 20</td>
<td>1.0</td>
<td>26.7 a 11.8 b 7.7 bc 6.8 bc 8.8 ab 6.2 ab</td>
</tr>
<tr>
<td>Triumph 4E</td>
<td>1.5 oz/1000 ft&lt;sup&gt;2&lt;/sup&gt;</td>
<td>24.2 a 4.7 c 3.3 c 1.7 c 2.7 b 3.7 b</td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td>21.8 a 27.3 a 15.2 a 14.5 ab 19.5 a 8.7 ab</td>
</tr>
</tbody>
</table>

<sup>*</sup> Means within a column followed by the same letter are not significantly different (P=0.05; DMRT)

Source: Michigan State Univ.

**Ant control in turfgrass**

- Triumph 4E was shown to be the best
control for ant mounding in a test done by
staffers of the Department of Entomology,
Michigan State University, in 1990.

At three and four weeks after the
August 15th treatment, Triumph 4E had
significantly reduced ant mounding in
comparison with the control. At one and
two weeks after treatment, most insecti-
cide products reduced mounding. None of
the products tested was effective five
weeks after application.
Preventing nitrate leaching

- Nitrate losses on many fertilized grassy areas on many soil types are no greater than those on unfertilized areas, according to research from Cornell University.

“There are some cases, however,” says Cornell’s Dr. Norman W. Hummel Jr., “where the potential for nitrate leaching does exist.” Conditions that promote leaching, he says, are:

- sandy soils;
- too much water from irrigation or rainfall;
- applying more fertilizer than necessary; and
- using water soluble (quick release) fertilizers in the late fall.

Hummel, speaking at a Virginia Turfgrass Conference convention, noted three actions that turf managers can take to prevent nitrate leaching. They are:

1) Use slow-release fertilizers. “Research has shown that leaching of nitrates on even sandy soils can be prevented,” Hummel says. “Most slow-release fertilizers release nitrogen at a rate similar to plant needs. Therefore, very little nitrogen is left to be leached out of the rootzone.”

2) Don’t over-fertilize. “Apply no more than one pound of actual nitrogen per 1000 sq. ft. at one time, unless a 100 percent slow-release material is used.” The table above lists fertilizer rates to deliver this nitrogen rate using different analysis fertilizers. Please, however, reduce these rates by 1/3 if clippings are returned after mowing. “Also, older lawns will require less nitrogen due to a build-up of soil organic nitrogen that occurs through time,” Hummel notes.

3) Don’t over-water. Apply only enough water to moisten the rootzone (about 3/4 of an inch of water on dry soil). “Too much water will drain through the profile, carrying nitrates with it,” Hummel concludes.

### NITROGEN REQUIREMENTS PER 1,000 SQ. FT.

<table>
<thead>
<tr>
<th>Pounds nitrogen**</th>
<th>Urea 46-0-0</th>
<th>10-5-5</th>
<th>16-8-8</th>
<th>25-3-3</th>
<th>20-3-7</th>
<th>20-5-10</th>
<th>SCU 35% N</th>
<th>Natural org. 6% N</th>
<th>Ureaform 35% N</th>
<th>IBDU 31% N</th>
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<tbody>
<tr>
<td>1/2</td>
<td>1</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>21/2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>10</td>
<td>61/2</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>11/2</td>
<td>1</td>
<td>15</td>
<td>91/2</td>
<td>6</td>
<td>71/2</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>2</td>
<td>*</td>
<td>20</td>
<td>13</td>
<td>8</td>
<td>10</td>
<td>51/2</td>
<td>331/2</td>
<td>51/2</td>
<td>61/2</td>
<td>12</td>
</tr>
<tr>
<td>21/2</td>
<td>*</td>
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<td>10</td>
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<td>8</td>
<td>50</td>
<td>8</td>
<td>10</td>
<td>12</td>
</tr>
</tbody>
</table>

* Not recommended at these rates. ** Recommended Source: Cornell University

Hummel also suggests avoiding fertilizers that contain a large percentage of urea, ammonium nitrate, ammonium sulfate or ammoniated phosphates, especially if used in the late fall.

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