Understanding Turf Management

The fifth in a series by
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MOVEMENT OF WATER IN SOIL

In the last article of this series an explanation was given of the physical principles by which water is held in the soil. Water, however, does not remain stationary in the soil, but is continually moving. Water always moves from places where there is a high amount to places where there is a lesser amount. Primarily the water is moving downward due to the pull or forces of gravity. This type of water movement is called gravitational flow. Nevertheless, at the same time water may be migrating sideways, or even upward due to the capillary forces generated by the occurrence of the small **micro** pores in the soil.

Capillary Flow

While it is easy to understand that water will move down due to gravity the concept of capillary flow is less obvious. As the flow by capillary forces is through the micro pore it is often referred to as unsaturated flow. Capillary flow is the movement of water at moisture contents of field capacity or less.

A simple illustration of capillary movement is to fill a glass to the brim with water and place a dry sponge over one half of the glass. The water in contact with the sponge will be immediately move **upward** into the sponge. If water is slowly added to the glass to maintain contact between the sponge and the water, it will soon be noticed that the sponge is being wetted **sideways** from the edge of the glass as well as **upward**. The water is moving from an area of high concentration (in the glass) to an area of low concentration (in the dry sponge, both above and beyond the edge of the glass). Of course the capillary movement of water also acts in a downward direction to increase the rate of flow due to gravity.

Capillary movement of water is of great importance in supplying grass roots with water because it allows water to be replenished at the surface of a root as the zone within a millimetre or two of the root dries out due to the absorption of water by the grass.

The amount of water that will move to the root by this process and the speed at which it moves is dependent on the size, number and continuity of the micro pores. Large numbers of relatively small micro pores are to be found in clay soils, therefore, capillary movement is of greatest significance in fine textured soils.

The smaller the micro pores, the further the water can move by capillary forces. On the other hand, the slower it will move. In a sand-based rooting zone with relatively large micro pores, water can move relatively rapidly over a short distance to a root surface. In the sand the distance over which the water will travel, however, will be measured in centimetres regardless of the time allowed. In a clay soil the water may move several feet, however, it will take weeks for this to occur.

The principle of capillary flow is employed in the design of sand-based sports fields. In this design a rooting zone of 30 cm. of sand overlies gravel which creates a temporary, 'perched water table' or zone of saturation of a few centimetres depth at the base of the sand. Water may move upward from this saturated zone to replenish the water surrounding the roots near the surface at a sufficient rate and quantity to be of importance in the growth of the turf.

Under normal soil conditions the movement of water from a water table by capillary flow at a rate to be significant in growing grass is limited to less than two feet. Furthermore, because of the relationship between soil air and water, it is preferable in sports fields constructed on natural soil materials to not have a water table within two feet of the surface. Tile drainage is recommended to prevent the water table from coming closer to the surface.

Gravitational Flow

Flow of water by gravity is important in the rapid removal of excess water and the return of air to the system. Gravitational flow, often referred to as saturated flow, occurs in the macro pores of the soil and only occurs when the moisture content of the soil rises above field capacity.

When gravitational flow is restricted it is necessary to install artificial drainage systems. Removal of gravitational water, however, does not remove any water of value in the production of grass.

Infiltration Rate

An important measurement of soil water movement is the rate at which water enters the soil surface - the infiltration rate. The value is an indication of the potential for erosion or water runoff, an event which seldom occurs with a turf covered surface. Under sports field conditions localized ponding may occur after heavy rains if the infiltration rate is low. It must be

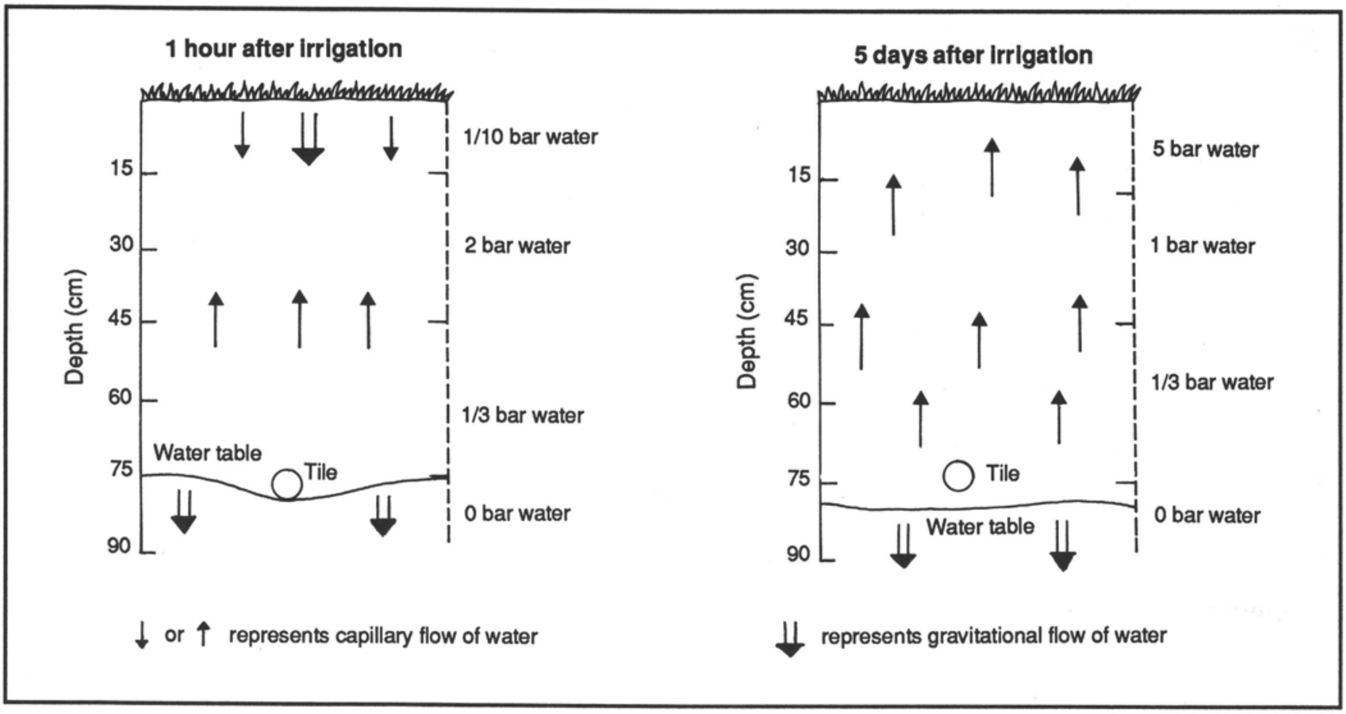

Fig. 1: The direction and type of movement of water in a soil profile under turf one hour and five days after irrigation or rain. The approximate tensions on the water at different depths are given on the right side of each diagram.

remembered that where the infiltration rate is low the rate at which irrigation water may be applied must be restricted.

Generally the infiltration rate in soils growing turf is related to the clay content, the degree of compaction and the occurrence of thatch. Soils high in clay have a lower infiltration rate than sands due to the lower percentage of macro pores. Similarly compaction, which tends to reduce macro porosity, restricts the infiltration rate. Dry spots occur where there is thatch build up, particularly if the thatch is allowed to become air dry. Due to the resistance to rewetting, the water tends to run to areas where the thatch is thinner or has not dried to the same degree, causing uneven wetting of the soil.

Generally an infiltration rate slightly greater than the expected intensity of storm rains is desired. Under Ontario conditions the intensity is seldom greater than 7.5 cm. per hour. Sand-based systems which have properly selected sands will have an infiltration rate meeting this standard.

Textural Barrier

Playing field construction using an imported material of significantly different texture from the underlying material, creating a 'textural discontinuity' or 'textural barrier', may result in a 'perched water table'. A 'perched water table' is a temporary zone of saturation because gravitational flow of water is restricted.

Textural barriers occur in sports fields under two widely different conditions. The first condition is where a coarse material, such as sand, is placed over clay. The percolation rate in the clay may be 1000 times or more slower than in the sand, resulting in a temporary saturated zone of a few centimetres at the surface of the clay layer. Eventually as the soil dries the sand will, in reality, dry faster due to the increased suction placed on the sand layer from the fine micro pores in the underlying clay.

The second condition is found where a fine sand material is placed over small stone. Again, due to the marked difference in pore size, water will not move from the sand into the stone layer until a zone of saturation builds up at the base of the finer material. The water must be at zero tension before it will 'drip' into the stone layer.

This second condition of a 'textural barrier' is an advantage in sand-based sports field construction because it provides a reservoir of water which may move upward to the active root growth area by capillary flow. By using the 'perched water table' principle greater water use efficiency is achieved and the frequency of irrigation is reduced.

It is interesting to note that at the surface of a drain tile a similar phenomenon occurs. Gravitational water does not enter the tile line until the tension on the water reaches zero. Therefore there will be a thin 'perched water table' at the surface of the tile until the soil moisture content drops to near field capacity. Placing stone around the tile only moves the 'perched water table' back to the interface between the stone and the soil material and does not speed up the flow of water into the tile.