UNDERSTANDING TURF MANAGEMENT
The eighth in a series by
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SOIL REACTION - pH

Much has been written about the soil reaction or pH. Many sports field managers lose countless hours of sleep worrying about the results of a lab analysis which indicated a high or a low pH. Understanding what is meant by soil reaction and its implications in grass production can save many hours of that lost sleep.

What does pH mean?

pH is a measure of the relative acidity or alkalinity of the soil and is measured by a pH meter in negative logarithmic units from 1 (very acid) to 14 (very alkaline). In physical chemistry terms pH is a measure of the hydrogen ion concentration in the soil solution. The lower the pH value the greater the concentration of hydrogen ions, that is, the more acid the soil . A neutral soil is one that has a pH of 7.0. Because the measuring system is logarithmic, a soil with a pH of 6.0 is 10 times as acid as one with a pH of 7.0. Likewise a soil with a pH of 5.0 is 100 times as acid as a neutral soil.

Soils in Canada, in their natural state, range in pH from 3.5 to 9.0. The acid soils are primarily sands which have being growing coniferous forests for centuries. Soils of pH 8.5 or greater are usually associated with the saline soils in the prairie regions of Western Canada which contain relatively high amounts of soluble salts.

Most Ontario soils have developed from materials of limestone origin and have a near neutral pH. Most Western Canadian soils also tend to be neutral or alkaline in reaction whereas soils in the Maritime provinces tend to be acid. Therefore, in Ontario, most sports fields constructed from local materials can be expected to have a pH near 7.0. An alkaline reaction is also usually associated with the sands used for construction or topdressing if they are obtained in Southern Ontario. Sands from the Canadian Shield, however, may be acid due to the granites and other igneous rocks from which they were formed.

With time, usually measured in decades, all soils become more acid. There are five basic factors which contribute to this slow acidification of soils.

- The formation of hydrogen ions during root respiration and microbial breakdown of organic matter.
- The conversion of ammonium nitrogen to nitrate nitrogen when ammonium fertilizers are used.
- The addition of elemental sulphur to a soil.
- The breakdown of clay minerals in the soil and the subsequent liberation of aluminum which reacts with water to produce hydrogen. This breakdown speeds up as the soil becomes more acid.
- The leaching losses of calcium and magnesium which have a neutralizing effect on the hydrogen.

Obviously, the greater the biological activity such as root growth, the greater the leaching (excess irrigation), the more ammonium fertilizers and elemental sulphur that is added to a sports field, the more quickly it will become acid. In sports fields which contain significant amounts of clay and organic matter, however, the acidification process is counteracted by a phenomena known as buffering capacity. The buffering of a soil means the ability of the soil to resist a change in pH. Buffering capacity is due to the cation exchange ability of the clays and humus which will be described in a latter article. It must be remembered, however, that fields constructed on acid sands can become more acid relatively rapidly.

The effect of pH on grass

Why is the pH of the rooting zone considered a problem? The hydrogen concentration (pH) is not the direct problem as plants have been successfully grown at pH 3.0 in solution culture when all the nutrients are controlled and provided in a soluble form. The primary problem is that the pH of the soil has a significant influence on the ability of elements required for grass growth to be dissolved in the soil water. If, through a change in pH they become insoluble, or soluble at rates less than that required to supply the grass, a pH-derived, nutritional problem is created. If, on the other hand, they become too soluble, a toxicity problem is created.

Table 1 lists the pH at which the various nutrients required for grass growth are most soluble. With the exception of iron and manganese a neutral pH would be the most desirable.

Table 1: The influence of pH on the solubility of the nutrients required for plant growth.

Nutrient	Most Soluble pH Range	Least Soluble pH Range
Nitrogen	6.5 - 8.0	5.5 and lower
Phosphorus	6.5 - 7.2	less than 6.5, over 7.2
Potassium	6.5 - 8.5	6.5 and lower
Calcium	7.0 - 8.5	6.5 and lower
Magnesium	7.0 - 8.5	6.5 and lower
Sulphur	6.5 - 8.5	5.5 and lower
Iron	3.5 - 6.0	greater than 6.0
Manganese	4.5 - 6.5	greater than 6.0
Boron	5.0 - 7.0	less than 5.0, over 7.5
Zinc	5.0 - 7.0	greater than 6.0
Copper	5.0 - 7.0	greater than 6.0

The most widely discussed problem of pH in soils and its effect on plant nutrition is phosphorus availability. The solubility of phosphorus reaches a maximum between pH 6.5 and 7.2. Above 7.2 the solubility decreases due to the formation of relatively insoluble compounds of calcium and magnesium; below 6.5 the solubility decreases due to the formation of relatively insoluble compounds of iron, aluminium and manganese. All forms of phosphorus found in the soil have a low solubility in water, however, it takes time, measured in months or years for the phosphorus to reach the low solubility such as that found in the original phosphate mineral, apatite. The further the pH deviates from the optimum the less time required to form the very insoluble forms. Therefore, a program of regular phosphate fertilization, based on an approved soil testing procedure, is a more realistic approach to pH than an attempt to change the pH.

The lower concentration of nitrogen and sulphur in the soil solution at a pH less than 5.5 is due to the decrease in the activity of soil microbes that convert the various nitrogen and sulphur forms in the soil to the forms which a grass root can absorb. Iron and manganese increase in solubility as the pH falls. In fact, one of the major reasons for liming a soil to increase the pH is to reduce the solubility of manganese which can be toxic to grass roots at high concentrations.

The four minor elements, iron, manganese, zinc and copper decrease in solubility as the pH rises above 6.0, causing unnecessary concern for field managers whose soils are testing 7.5. The concern is unnecessary in most cases because these are minor elements; elements required in very small amounts for plant growth. Only a few species, grass not being one of them, respond to applications of these minor elements, even at a pH greater than 8.0. If a response is to be found, it will be on sands, very low in organic matter. Grass species have a very low requirement for boron and it has never been reported as a deficiency problem. However, in saline conditions in arid regions on soils with a pH above 8.0, boron may become soluble enough to be toxic.

Changing the pH

Changing the pH is not a simple procedure. If one wishes to increase the pH of an acid soil to the neutral range it is necessary to add a liming material, generally calcitic or dolomitic limestone. The dolomitic form of limestone is used where a magnesium deficiency is know to occur because it is a mixture of calcium carbonate and magnesium carbonate. Two other liming materials, quicklime and hydrated lime, may also be used but caution in their application must be taken because they are caustic to the eyes and skin.

Limestone is very slowly soluble in water, thus it is necessary to use very finely ground material - 85% should pass a 100-mesh screen. Because limestone is slowly soluble, it is best mixed with the soil materials for the upper 15 cm of the rooting zone prior to construction of a sports field. Application to an existing field may require several years to show an affect below the first few centimetres. To speed up the penetration of the liming materials applications should be made during a coring operation.

To determine the amount of limestone to apply it is necessary to do a standard pH measurement. If the value is below the desired target pH for the turf, i.e., 6.0, the a second pH measurement known as the 'buffer pH' is made. The buffer pH reflects the difference in soil buffering capacity of soils due to their different clay and humus contents. For example a high organic matter, clay soil will require more limestone to change the pH one unit than a sand. The amount of limestone required to raise the pH to the target pH is shown in Table 2.

The turf species used in Canada do very well at a target pH of 6.0, hence the addition of limestone is seldom required. Table 3 outlines the preferred pH range for these species.

Some turf managers want to lower the pH of a soil which reads 7.8 or greater. It has never been shown that there is an advantage to doing so and the expense is prohibitive. There may, however, be localized horticultural situations where lowering the pH is desirable, such as the growth of azaleas. The materials which may be used are elemental sulphur, aluminum sulphate and sphagnum peat. Sphagnum peat generally has a pH between 2.5 and 3.0

The amount of sulphur or aluminum sulphate required to adjust the pH of the top 15 cm of soil to pH 7.0 is recorded in Table 4.

Table 3: The preferred pH range for the common turfgrass species grown in Canada.

Species	Preferred pH Range
Kentucky bluegrass	6.0 - 7.6
Colonial bentgrass	6.0 - 7.0
Creeping bentgrass	6.0 - 7.0
Creeping red fescue	5.5 - 6.5
Ryegrass	6.0 - 7.0

Table 2: The lime requirement to correct soil acidity based on the target pH and the buffer pH.

Buffer pH	Target pH = 6.5	Target pH = 6.0
	(tonne material/hectare)	
7.0	2	0
6.5	3	2
6.0	9	6
5.5	17	12
5.0	20	20

Table 4: The amount of elemental sulphur *or* aluminum sulphate required to lower the pH to 7.0.

Initial	Elemental Sulphur			Aluminum Sulphate		
pH	Sand	Loam	Clay	Sand	Loam	Clay
			(kg/100m^2)			
8.0	11.0	22.0	40.7	22.0	44.0	66.0
7.5	6.6	13.2	17.6	11.0	22.0	33.0

In summary it must be emphasized that materials to directly alter the pH should never be applied unless a pH determination has been made. Furthermore the pH should seldom be a concern for the turf manager. If it becomes excessively high (over pH 7.8) then be alerted to the possible requirement for a higher phosphorus test to satisfy the requirements of the grass. If the pH falls below 5.5 be prepared to apply some limestone during coring. In between enjoy a good night's sleep.

The Sports Turf Association welcomes new members:

Don Bridgman
Cambridge Parks

J.T. Dawson
McMaster University

Andrew Gaydon
Shemin Nurseries

Larry Glover
Belleville Parks

John Gravett
Turfecs, Guelph

Russell Loney
Loney Landscaping

Robert MacAuley
Univ. of P.E.I.

Christian Prud'homme
Pelouse Sante, Que

Dennis Weagant
Belleville Parks

Composting for Athletic Fields

Michael J. Bladon
Grounds Dept., Univ. of Guelph

Benefits of Composting

The principal benefit of composting is to recover or recycle biodegradable materials from agricultural, industrial and municipal waste streams in an environmentally acceptable manner to produce a useful, marketable product.

A second benefit is that the end product (compost) is a safe material which may easily be transported using regular commercial vehicles. The resulting material has many advantages and can be used in many ways.

For example, there is now evidence that compost can be used to suppress plant diseases, stabilize soil pH and impede the movement and uptake by plants of toxic metals such as cadmium and lead.

Furthermore, reclamation of strip mines, mine tailings and the rejuvenation of salt-damaged soil along roadways may be aided. In addition, compost recycles the plant nutrients so less fertilizer is needed.

Finally, the use of compost on sports fields for topdressing, construction or renovation instead of peat moss is important in two ways. It will help to preserve wetlands from which peat is harvested. Generally this harvest is a irreversible process with the destruction of the wetlands. The destruction of wetlands is now a serious environmental issue, especially among the wildlife people.

Peat moss is very expensive - compost is a much more reasonable economic alternative, in fact some landscape architects are including compost in their specifications. In a survey conducted by the lawn and landscape industry, the respondents categorized themselves as:

- 71.3% being generators of lawn waste (clippings, leaves, branches,
- 34.8% being collectors of lawn waste, and
- 33.0% being composters of lawn waste.

Of those contractors that were surveyed who collected waste and generated compost, 66% indicated they use it themselves, 26.3% gave the material away, and 7.3% sold the compost.

Getting Started

First of all, depending on where you live, obtain a copy of the Provincial Government Guidelines for aerobic composting. It will be apparent from reading these guidelines that in order to generate good compost you need a recipe which includes: air, moisture, correct C:N ratio, temperature and pH balance. Finally you will need at least an acre of land for every 1,000 tonnes of yard waste.

Air: The bacteria which break down organic matter are called aerobic because they need oxygen. Lack of aeration, because the pile is too wet, packed to tight, or is too large, can cause it to become anaerobic which can create odours objectionable to neighbours. Furthermore, anaerobic composting does not create sufficient heat (min. of 55° C) to kill weed seeds and various pathogens. So turning, and hence aerating, the pile during the composting process will provide the oxygen necessary for the aerobic bacteria.