The Nature of Soil Acidity and How it Develops

By O. J. Noer, Madison, Wis.

Many authorities, charged with turf maintenance, desire and strive to obtain acid soils, particularly on greens where bent grasses predominate. The bents appear to thrive in soils sufficiently acid to inhibit or prevent the growth of undesirable clover and weeds.

Sulfate of ammonia is most widely used to develop acidity. Besides its effect upon soil reaction, the sulfate supplies nitrogen, the plant food element most extensively used by grasses. Failure to control clovers and weeds frequently results from the use of supplementary materials which overcome the acid producing power of the sulfate.

A clear understanding of what constitutes soil acidity, how it develops, the effect of specific fertilizer materials, and the possibility of introducing lime or other alkaline material in sand, soil or water, must be considered in any program aimed to promote soil acidity.

Natural agencies tend to make soils either more or less acid. In humid regions (25 inches or more annual rainfall) soils gradually become acid, and less acid or alkaline in arid and semi-arid regions. During and after rains, the excess water as it passes down through the soil dissolves and removes more alkaline than acidic material, consequently the residual soil gradually becomes acid in character. In semi-arid and arid regions almost no water passes down through the soil. Evaporation at the surface tends to promote capillary water movement upwards and the dissolved materials, usually alkaline in character, accumulate as the water evaporates. Since these materials are water soluble they can be washed out of the soil. Removal is facilitated where tile drains are installed to carry the leaching waters away.

The rate at which acidity develops naturally depends upon the amount of rainfall, the type of soil, and the nature of the native material from which the soil was derived. The more thorough leaching in areas of heavy rainfall is self-evident, but that acidity develops more rapidly in sandy than heavy soils is not generally appreciated. If the parent rock from which the soil originated was low in alkaline materials, acidity asserts itself more quickly. Soils derived from limestone usually contain lime carbonate, and until removed, acidity develops slowly. Carbonic acid, always present in the soil water, gradually converts the insoluble lime carbonate into soluble bicarbonate which leaches from the soil. From 200 to 500 pounds of lime are annually removed in this way. Sulfate of ammonia hastens re-

moval by converting additional lime carbonate into soluble calcium sulfate which is also washed out in the drainage water. But until the lime carbonate disappears completely very little effect can be expected from sulfate applications so far as increasing soil acidity is concerned.

Chemists recognize three classes of substances, acids, bases and salts. As the name implies, acids are acidic in character, whereas bases are alkaline in character. Salts are usually neutral but may have acidic or alkaline properties. They are formed when chemical action takes place between an acid and a base, and may be either soluble or insoluble in water. Thus when hydrochloric acid (muriatic acid) and calcium hydroxide (hydrated lime) are brought together a salt called calcium sulfate (gypsum) is formed. This salt has neither acid nor alkaline properties but is neutral. When an acid and base react together they neutralize each other, each losing its distinctive properties. Yet salts are not always neutral. They may have acidic or alkaline properties. Just as the forceful individual dominates the weaker, so the strong, acid or base, imposes its will on a more feeble companion and the properties of the stronger predominate. Water may dissolve and remove acid or basic materials from insoluble neutral salts leaving a residue either acid or alkaline in reaction.

Soils consist essentially of exceedingly complex organic and mineral salts, almost wholly insoluble in water. It is from these substances that the more soluble basic materials are dissolved, and eventually removed from the soil by the percolating waters. The insoluble soil residue thus becomes acid in character, and is the reservoir from which soluble acidity develops, when soluble salts are added to the soil. The mechanism of the process can be demonstrated easily. If a fragment of granite rock is ground to a fine powder, placed in a bottle, water added and vigorously shaken, the water gradually becomes alkaline due to the solution of basic substances. When the water is removed the acid nature of the insoluble residue, caused by the solution of bases, can be demonstrated. If water containing a neutral dissolved salt (such as sulfate of ammonia) is now allowed to come in contact with the acid rock powder it becomes acid in character. The powder takes up and holds the basic portion of the salt (ammonia), and leaves a soluble acid (sulfuric acid) in the water. In humid regions the percolating waters dissolve and remove alkaline materials, leaving an insoluble soil residue capable of developing soluble acids when certain fertilizer materials are added to the soil.

The predominating opaque grains in sands are quartz or silica, a substance so insoluble and inert chemically that it has very little effect on soil reaction. Variations only result from changes in the fine mineral particles or inorganic matter, and since these constitute only a small portion of the sandy soils, changes occur more rapidly than in the heavier soils composed largely of silt and clay.

There is a rough correlation between the insoluble and soluble soil acids. Soils containing large amounts of insoluble acids are capable of yielding much soluble acidity. These are often referred to as potential and active acidity, respectively. It is the soluble or active acidity which controls growth of grasses, clover and weeds.

Soils have a remarkable power of resisting change in reaction. This power resides mainly in the organic matter, silt and clay par-

ticles, so permanent change takes place more rapidly and completely in sands than in the heavy soils. Repeated application of acid-producing fertilizers may be required to effect marked change of loam or heavier soil.

While there are a large number of methods for determining potential or insoluble acidity, it is the active or soluble acidity which concerns the control of clover and weeds. Portable sets for determining active acidity are now on the market and are all based on the same principle. Certain color indicators when placed in contact with the soil develop specific colors which are characteristic, and depend upon the intensity of the soluble acids. Differences are arbitrarily designated as Ph values. A neutral soil has a Ph of 7. Figures smaller than 7 represent increasing degrees of acidity, and those greater increasing degrees of alkalinity. The progressive changes are in units of 10. Thus Ph 6 is 10 times more acid than Ph 7, and Ph 5 is 100 times more acid than Ph 7 or 10 times more acid than Ph 6. Differences of .2 Ph can be distinguished easily.

Experiments indicate that clovers grow best at Ph ranges of 6 to 8. At about Ph 5 clovers usually are unable to exist, and it is doubtful if they can thrive in the range of Ph 5.5 to 6. In order to secure effective clover control these values should be obtained.

In the next article the effect of different fertilizer materials on soil reaction will be discussed.

"First Aid to the Beginner"

By A. G. Chapman, Chairman, Green Committee, Audubon Country Club, Louisville, Ky.

MR. CHAIRMAN AND GENTLEMEN:* Being conscious as I am of my inexperience and realizing that the majority of those present today are at least by comparison advanced students of the game, I am fully justified in the embarrassment from which I am suffering at this time. Frankly, I doubt seriously if I can present anything to you worthy of your time. In my business of insurance it is a well-known fact that when an agent is first appointed he feels that the mass of details are almost beyond his power to master; after six months he begins to think they are easy and by the time he has reached the third six months of his service he almost invariably makes many suggestions to the executive officers as to their policy and general conduct of the business.

It is somewhat discouraging to observe the manner in which your work is received by some people of this country who are interested in, or who are supposed to be interested in, the efficient maintenance of golf courses. I think I am correct in saying that you get little support and find comparatively scant interest in what you are doing from my section of the country, where it is too far north to raise Bermuda and far enough south to make bent grass difficult. It is obvious that the folks in my section need your services more than any other.

On behalf of the newly appointed green chairman everywhere, and particularly in my section, I plead for your great patience and consideration. Please bear in mind that with most of us it is a matter

*Address given at annual meeting of the United States Golf Association Green Section at New York City, January 6, 1928.