# Soil Acidity and Lime for Bent Turf

By John Monteith, Jr.

Many years ago it was observed that in a general way the bent grasses thrived best on acid soils. It was found that sulphate of ammonia and certain other nitrogen fertilizers which tended to make soils more acid resulted in a great increase in vigor of the grass and a reduction in weeds. On the other hand, fertilizers such as nitrate of soda, which tended to make soils less acid, were found to encourage weeds and to be far less beneficial to turf. Experiments at the Rothamsted Experiment Station in England and at the Rhode Island Agricultural Experiment Station indicated that turf was decidedly improved when repeatedly fertilized with sulphate of ammonia, which tends to make soils more acid. Experiments at the Arlington turf garden initiated somewhat later showed very favorable results with ammonium phosphate as well as with sulphate of ammonia. The ammonium phosphate, which also tends to make the soil acid, had a somewhat better effect than the sulphate of ammonia, supposedly because the phosphate residue left in the soil after the ammonia was taken up had a better effect in the soil than the sulphate residue left from sulphate of ammonia. These observations and experiments led to the belief that bent grasses needed decidedly acid soils and that the common weeds of turf were discouraged by an acid condition of the soil. As a consequence the so-called "acid theory" was developed and widely endorsed by those who were the closest followers of turf-culture studies. There were case after case added to the records of poor, weed-infested turf being almost miraculously improved by repeated and heavy applications of sulphate of ammonia. It was only natural that the large amount of evidence that accumulated should win many enthusiastic converts to the acid theory. The beneficial effects of the acid-reacting fertilizers were attributed primarily to their changing the acidity of the soil. Failures to obtain desired results were attributed to insufficient change of the acidity of the soils in question, and heavier rates of application were recommended for these cases.

The acid theory was subject to two serious handicaps. In the first place, its increasing host of enthusiastic supporters, like the enthusiastic friends of any new principle that has shown some definite results, extended the claims far beyond the limits that were acknowledged for it by those who first sponsored it. In the second place, the theory was based on the overemphasis of a single factor. Even though there was an abundance of evidence which seemed to clearly indicate a direct correlation between the improvement of turf and the increased acidity of the soil, there had been no direct proof that the change in acidity was the only important factor in accomplishing this improvement.

It is interesting to note that the acid theory came into general application in turf culture at a time when lime was generally used in great excess on grass for both lawns and golf course turf. Lime was used as a fertilizer, and in many cases nothing else was applied to turf. As a result the soil soon became greatly depleted of nitrogen. Then clovers or other legumes which could obtain nitrogen from the air were able to compete successfully with grass and in many cases soon dominated the turf. Under those conditions any fertilizer that provided nitrogen in a suitable form was almost certain to produce

startling results. Sulphate of ammonia and ammonium phosphate provided nitrogen in this form and proved to be of unusual value to turf which had little nitrogen available in the soil. Much of the popular conception of unparalleled benefits of sulphate of ammonia was based on a comparison of its effectiveness as compared with lime rather than on a comparison with other fertilizers containing an equal amount of nitrogen in readily available form.

It had been noted that on some putting greens where sulphate of ammonia had been used in large quantities there had been no noticeable change in soil acidity. This was due to various causes, among which were the large reserves of some form of lime in the soil, the use of sand with a high lime content in the preparation of topdressing material, and the sprinkling of greens with hard water that contained large quantities of lime. In such cases even without any change in soil acidity the heavy applications of sulphate of ammonia in many instances accomplished the desired result of improving the bent turf and reducing the weed content. In other instances, even though the soil was made decidedly acid it was found that the results obtained from the use of heavy quantities of sulphate of ammonia did not come quite up to expectations. Such observations naturally raised questions as to how widely applicable was the acid theory.

At the Arlington turf garden it was found that the acidity of the soil had been decidedly increased in plots which had received sulphate of ammonia or ammonium phosphate for a period of years. As early as 1922, however, it was noticed that the colonial bent grass on these plots, although producing good turf throughout most of the season, showed a tendency to become easily injured in periods of extreme heat during the months of July and August. This periodic injury seemed increased from year to year, and excessive acidity was suspected as one of the contributing causes. In 1926 some experiments were started at the Arlington turf garden to determine the effect of lime on such injured areas. The response was favorable and further tests were started. The investigation of turf diseases about this time had also led to the observation that plots which had been fertilized excessively with sulphate of ammonia were more susceptible to the dollarspot and brownpatch diseases and to nonparasitic injury commonly designated as scald. A number of tests at the Arlington turf garden showed that these injuries on plots which had been fertilized excessively for a long period with this acid-reacting fertilizer could be decidedly reduced by an application of lime. These observations were published in the May, 1929, Bulletin. The publication of this Bulletin was heralded by many as marking the end of the acid theory in bent culture. This, however, was not the case. It merely served as a warning against the extreme application of this theory. It indicated that the use of certain of these acid-reacting fertilizers could be overdone and that the previous extreme position which led to the tabooing of lime on golf courses was erroneous. A few extremists unfortunately took the cue from the May, 1929, Bulletin to again use lime recklessly on golf course turf. The Green Section work reported in the May, 1929, Bulletin gave no indication of definite pH limits, and consequently no recommendations were made. As observations were continued at the Arlington turf garden and the Mid-West turf garden, further evidence was obtained indicating that other factors were involved and that the question could not be resolved into a simple matter of prescribing

any definite degrees of soil acidity. All of the contentions on which this question of soil acidity had been argued were based on general observations or experimental work in which there was a conflict of various factors, and no definite work had been performed in which these various factors could be considered separately. The conflict of evidence clearly indicated that such work was desirable, and the Green Section therefore undertook the task of determining more definitely the influence of soil acidity on the growth of bent. Some of the results of this work are presented in this number of the Bulletin.

The experiments indicate in general that bent grasses can tolerate a wider range on the acid than on the alkaline side. They have also shown that with one type of soil, Metropolitan bent grew best when the soil reaction was decidedly acid, pH 4.5, whereas with another type of soil its best growth occurred when the soil was decidedly alkaline, pH 8.3. These wide limits indicate the folly of prescribing definite acidity limits for all soils. Although one of the soils used in the experimental work gave the best growth when alkaline, it is probable that most soils used on golf courses give best growth of bent grasses when they are somewhat acid. The experiments showed that the kind of acid in the soil was an important factor. The chemical effect of acids or lime on plant-food materials in the soil also appears to be an important and at times a determining factor. There are many other interrelated factors that exert important influences on turf production whenever there is a change in soil acidity. All of these results clearly explain why there has been so much conflicting evidence injected into the discussion of the question as to how acid soil should be for bent turf. They explain why the Green Section prescribes no definite limits as to degree of soil acidity. They further indicate the importance of certain factors that have been given little consideration in the past, and clearly show the need for further experimental work to determine more accurately many of the factors that influence turf production, to the end that course maintenance be based on knowledge rather than on mere argumentation and speculation.

Individuals in charge of a golf course naturally will ask how this information can be applied to turf culture. The Green Section has been asked to define its policies on soil acidity and the use of lime based on present information. Its position on these questions is briefly defined below.

The bent grasses seem to thrive best on most soils if they are slightly acid. Therefore fertilizers which tend to make soils more acid or have a neutral effect are to be preferred to the common fertilizers which make soils less acid or alkaline.

Any extreme change in acidity should be avoided unless carefully conducted experiments indicate that such a change is desirable.

Juggling of soils to bring them within certain prescribed limits of acidity as expressed in terms of pH is not justified in the light of present knowledge.

The use of sulphur or other materials chiefly to increase soil acidity is considered unwise.

Tests of soil acidity by means of the various devices for determining degrees of acidity expressed in pH or in "lime-requirement" should be regarded simply as useful indicators and not as final proof that a soil needs some change in its degree of acidity or alkalinity.

Lime should be used as needed to correct excessive soil acidity or

to correct the harmful effect of excessive use of certain fertilizers, such as sulphate of ammonia or ammonium phosphate, even though they may not have made the soil acid.

Excessive use of lime should be avoided on golf course turf just as excessive use of any other chemical should be avoided.

The need for lime by turf is expressed in various ways. One of the most common symptoms in bent grasses is a yellowing and generally unthrifty appearance especially during the heat of midsummer. Yellowing may be due to excessive watering, shortage of nitrogen, or other unfavorable conditions. However, if the soil and moisture conditions are favorable and turf does not promptly respond to an application of a fertilizer containing nitrogen in readily available form, as sulphate of ammonia, it indicates that lime may be needed. If brownpatch and dollarspot are extremely active and they are not easily controlled by the customary mercurial fungicides this also may be regarded as an indication of lime shortage. If irregular patches of turf turn brown as though scalded and the soil in these patches dries and becomes almost impervious to water there is a possibility of lime deficiency. Any of the symptoms of lime deficiency may be produced by other causes and may therefore be misleading. However, if considered collectively, they are of great importance in pointing to the need for lime. If tests with one of the acid testing kits show that the soil is decidedly acid it may safely be assumed that if the above symptoms appear the soil will be benefited by an application of lime.

Too much emphasis has been placed in certain districts on the determination of lime requirements of golf course soils by means of the test kits that determine acidity by chemical means. The Green Section fully recognizes the usefulness of such tests in scientific work or in rapid diagnosis of many soil difficulties. In greenkeeping they serve simply as useful instruments to provide supporting evidence in a diagnosis. They do not provide the definite and conclusive proof of lime requirement that some greenkeepers and green-committee members have been led to believe. The chemical tests sold for popular use are easily read, but are devised to show only one thing and are not intended to indicate anything about the complication of other factors that influence the growth of grass. Although not as easily read, the grass itself is a far better indicator of soil requirements than any chemical yet devised. The greenkeeper can accomplish far more by studying the responses and symptoms of grass than he can by learning how to operate the various test kits that are on the market. Tests for soil acidity should be used only as a guide, as is indicated in the following examples.

If soil is tested and found to be about pH 4.5 it is probably too acid for the best growth of bent. However, this is not necessarily so. If the grass has definitely shown some of the symptoms mentioned above, it would be well to apply lime. If on the other hand the grass continues thrifty there need be no alarm at this low pH reading and lime should not be applied without adequate testing.

In the case of an alkaline soil, such as that on which the Mid-West turf garden is located, repeated applications of sulphate of ammonia may only slightly change the degree of alkalinity. A pH reading in such cases may be 7.5, which would indicate no lime was needed. Nevertheless when the symptoms of the grass as mentioned above indicate lime deficiency, it has been found that where lime was

added the result in the pH 7.5 soil was quite similar to that obtained on the pH 4.5 soil.

In most cases it will be found that the lime content of the soil is not sufficiently exhausted to cause the turf to exhibit the distinct symptoms of lime deficiency, except under severe climatic conditions. In such cases lime should not be applied indiscriminately, for there may already be more lime than is needed in the soil.

On many golf courses where no direct applications of lime have been made in recent years there have been large quantities unknowingly applied in hard water or in sand used for topdressing. In any case the development of lime deficiency is a gradual process; and if the turf is carefully watched any deficiency can be detected well before it produces disastrous effects.

The safest way to use lime on a golf course is to first try it on small definite areas. A 10-foot strip of lime across a putting green or a 20- to 50-foot strip across a fairway provides a simple test which, if closely watched, will give much more accurate information on the lime requirements of soil than will any other test now available. This method is somewhat slow; but it is seldom that any great speed is necessary in applying lime, except when the shortage is so marked that unmistakable evidence of such shortage is available. In making this test, lime should be applied at the rate of 25 pounds to 1,000 square feet of putting greens and 1 ton to the acre on fairways. For quick results, hydrated lime should be used. The test areas should be marked with string before the lime is scattered, and care should be taken to distribute it to the edge of the plot but not beyond it in order that there may be a clear distinction between the limed and unlimed areas. If throughout the season there is no sign of impoverishment in the turf that is limed as compared with the turf beside it that received no lime, it is obvious that liming is unnecessary. These tests are simple to perform and may avoid the cost of liming and the possibility of some danger to the turf. The custom of giving lime a trial by liming the entire course without some system of checking results previously is to be condemned, for it is a sign of guesswork greenkeeping.

Hydrated lime should not be put on turf within about 10 days after applying fertilizers containing ammonium salts. Neither should such fertilizers be applied for several days after hydrated lime has been spread on turf. Neglect of these precautions may result in severe burns, due to the release of ammonia gas.

The above-suggested rate of liming for trial plots is somewhat lower than that which yielded the best results in one of the soils used in the experiments described in the following article. This is chiefly because in the pot cultures the lime was mixed through the soil to a depth of over 6 inches, thus making application of the quantitative aspect of the results of value more particularly in connection with construction work. Under field conditions, when lime is applied to the surface it becomes effective in lowering the acidity first of the upper portion of the soil, later extending gradually to lower levels. Since in most turf the feeding roots are fairly near the surface, the effects even of light liming may soon be observed.

The harmful effect on turf of excessive amounts of sulphate of ammonia is not to be interpreted as an objection to the use of the fertilizer on golf course turf, particularly of the bent grasses. It is harmful if used in excess; but in this respect it is simply like many

of the other materials that are so useful in greenkeeping, including such things as water, lime, and fungicides. Sulphate of ammonia is still regarded as one of the best fertilizers for golf course use. The more recent observations and experiments have simply indicated that it is not the cure-all some enthusiasts once supposed it to be, and that regardless of acidity it must be properly balanced with other materials used for plant food in order to give best results in turf culture.

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### The "Herbae-Mira" Fraud

As early as January, 1924, the Bulletin issued a warning concerning the nefarious scheme of one Allan Ward Miller to defraud prospective purchasers of grass seed. Advertising leaflets, clever sales talk, and trays or samples of luxuriantly growing grass were used to entice greenkeepers, large property owners, and others to purchase a low grade seed at $2 a pound. Miller used the name "Herbae-Prati" for his seed mixture after originally using such names as "turfing fescue" and *"Festuca elatior,"* but these failed to catch the public eye and the name was changed to "Herbae-Prati." Most of this mixture was composed of common meadow fescue worth only about 10 cents a pound.

The Department of Agriculture and the Post Office Department made it so uncomfortable for Miller that he ceased operations for a while, later renewing his fraudulent activities and advertising the seed under the name "Herbae-Mira."

Miller was denied the use of the mails and fraudulent charges were filed against him. He was indicted several times during the past six years but avoided being brought to trial by creating complications in addresses and by changing the mixture of "Herbae-Mira." Miller operated through such agencies as "Forest Lawn Improvement Company" of Chicago; "Zenith Lawn Improvement Company of Kansas City; "Wilshire Lawn Improvement Company" of Dallas; and requested cash with orders. In some instances no office was maintained in the cities as advertised, and mail was forwarded to another destination from which point Miller directed his sales.

In February, 1930, Miller was arrested in Price, Utah, on a charge of petty larceny in connection with alleged misrepresentation of "Herbae-Mira" seed. He was fined $275, given a suspended jail sentence of six months, and ordered to repay $65 to the parties he defrauded. Again, in January, 1931, Miller was arrested, tried, and sentenced in the Circuit Court of Peoria County, Ill., to serve from one to ten years in the State Penitentiary at Joliet, Ill. He was charged with operating a confidence game and obtaining money under false pretenses.

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Most value is obtained from manure when it is used in the compost pile. An excellent compost consists of one-fifth manure and four-fifths sandy-loam topsoil.

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The ideal texture of soil or compost is such that after being compressed in the hand it will retain the form to which it is compressed but will fall readily apart when touched.