SOIL TESTS*

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Chemical and Physical Analyses of Soils Are of Value Only When Weighed Against Other Factors Always Present

DURING the past three or four years, rapid progress has been made in the development of really valuable chemical methods for soil examination and diagnosis in connection with fertility problems. Some of these improved methods for soil testing have been in use, in the laboratories of agricultural colleges and experiment stations, for a sufficient length of time to show that if they are properly applied and interpreted, they may provide a valuable index to the fertility of a soil.

Until quite recently, the use of these newer chemical tests has been restricted to the laboratories where soil examination and advisory service has been maintained for samples sent in by farmers, and others. The demand for this service has grown so rapidly as to make it difficult to take care of all the work in the laboratories alone. To meet this increasing demand and to extend the scope of the soil testing service, several of the systems for chemical testing of soils have been modified and adapted in such a way as to make possible testing the soil right out in the field.

Among those, outside of the agriculturists, who have become more and more interested in soil problems, are superintendents of parks, landscape and golf architects, green committees and greenkeepers from the various golf courses. Some greenkeepers have purchased soil test kits and have used them regularly, in checking up on soil conditions in greens and fairways. As time goes on, more testing of this kind will likely be done.

In the final analysis, the soil problem often becomes a very local one, perhaps peculiar to a particular green or fairway. The individual greenkeeper in such case, requires more than general principles to work on; he wants specific information on the soils from the particular course for which he is responsible. What are the limitations in the use and interpretation of chemical tests, made either on the spot or in the laboratory, and what information may he reasonably expect to obtain from such tests?

At the outset, it is obvious that the golf course presents soil problems quite unlike those met with in ordinary cultivation. This is particularly true of the greens, which are essentially artificial in structure, soil character and cultural treatment. Because of the peculiarities of turf culture on the greens and the use made of them, physical and biological features of the soil become most important factors determining the quality of turf.

Physical Condition of Soil Important

Chemical tests of the soil give practically no information about the important physical factors affecting plant growth, such as drainage, water supply, aeration, and permeability to root penetration. Nor do they give a satisfactory clue to the biological activities of the soil responsible for the turnover of organic matter and the making available of the nutrients it contains. These limitations of the chemical tests apply in dealing with any soil, it is true, but they are especially pronounced in connection with the diagnosis of green soil problems.

If the testing is done at the green, where the physical condition of the soil, the depth of penetration of the grass roots, the possible presence of disease and other factors may be observed and evaluated, the chemical tests may be more safely interpreted, provided, of course, they are properly conducted. In the case of samples of green soils sent to the laboratory, even though the chemical methods of examination may be more accurate and complete, physical, biological and other factors may be responsible for the undesirable condition of the turf and the chemical tests fail to throw light on the cause of the trouble. This has been experienced many times in the course of our advisory work on golf course soils, but the fault does not lie with the tests themselves, since they are intended to study chemical and not physical factors of the soil.

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Chemical tests on soils are designed to determine, with varying degrees of accuracy, the reaction and content of soluble nutrients in the soil. The presence of toxic substances or excessive amounts of certain substances is also detected by the more complete methods of examination. Most important among the tests usually made are the following: the reaction, whether acid, neutral or alkaline, and if not neutral, the degree of acidity or alkalinity; soluble nitrogen, phosphorus, potassium, calcium and magnesium; chlorides, sulphates and carbonates. The test for soluble nitrogen compounds may be only for nitrates, or may include nitrites and ammonia. In strongly acid soils, tests are also made for soluble aluminum. Such a complete series of chemical tests gives a good idea of the relative amounts of the various constituents in a readily soluble form.

It is generally assumed that fertile and productive soils contain much larger amounts of soluble nutrients than infertile or run-down soils, and that fertile soils have the capacity to maintain the higher level or supply of soluble nutrients throughout the critical period of the growth of the plant. Chemical tests of soils to determine the content of easily soluble nutrients are considered to give an index to the possible supply of plant food and to throw some light on the relative amounts of the various constitutents, or the "nutrient balance", which is quite as important. When all other factors are favorable for the plant, growth may be limited if the supply of one or more nutrients is too low, or so high as to cause a toxic condition.

Test Results Need Weighing

Chemical tests, in estimating the amounts of easily soluble nutrients in a soil, are of great value in indicating high or low supplies and relative deficiencies or excesses. Although the content of easily soluble nutrients in a soil is fairly well determined by these chemical tests, it does not necessarily follow that the tests indicate what the plant is able to utilize. The plant may be able to get an adequate supply of the necessary nutrients from one soil, which by chemical tests, gives a very low soluble nutrient content at any instant, while another soil, with high soluble nutrient content, may fail to sustain normal growth. Attention is called to this point, to emphasize the fact that the chemical methods of soil testing are essentially arbitrary in nature and do not necessarily extract from the soil exactly the same amounts or proportions of nutrients taken up by the growing plant. Further, the chemical test provides an index to the soluble nutrient supply only at a particular instant. At other times during the growth period of the plant, the food supply may be shown to be quite different.

In spite of the above considerations, chemical tests have a real practical value in providing information that cannot be obtained in any other way. They must be used, however, with a true knowledge of what they can indicate in a reliable and accurate way.

The above limitations of chemical tests in revealing the available nutrients of the soil are, in part, overcome by correlating the test results with actual plant response in the field. By testing large numbers of soils from fields of known treatment, with and without fertilizers, and from experimental plots where crop performance and crop yields are obtainable, it has been possible to calibrate the tests so that the results may be more safely interpreted. Most of the tests used in the laboratory or in the test kits designed for field use, have been calibrated in such a way.

This is a further limitation to the wholesale application of any system of chemical tests to golf course soils. Since these tests have been calibrated to indicate high, medium and low levels of easily soluble nutrients for farm crops on field soils, it does not necessarily follow, that the same standards can be adopted for grading the results of tests on golf green soils at least. There is, however, greater likelihood of obtaining more satisfactory results on fairway soils.

No matter how good the chemical tests are in themselves, the results will have to be calibrated against turf performance on the golf courses before they can be satisfactorily interpreted in terms of deficient or adequate supplies of plant food, and fertilizer recommendations for greens and fairways. This is one of the fundamental problems to be dealt with if the results of chemical tests on golf course soils are to be made more reliable and useful. Fortunately, some attempt is being made in this direction.

Careful Sampling Necessary

No matter how good the scheme of chemical analysis, or how accurately it is done, the value of the results depends on whether or not the sample is representa-

Instructors and students of the 1935 Winter School for Greenkeepers, which began Jan. 2 and will continue until March 17, at Mass. State College. Prof. L. S. Dickinson, director of the class, stands in the center of the first row.

tive of the soil condition under study. Too much emphasis cannot be laid on the importance of having a representative sample for the test. Failure in this may make the results and their interpretation practically worthless.

No hard and fast rules can be laid down for sampling under all conditions. Our experience has been that a sample from a single spot in a golf green is not satisfactory. In sampling a green, several cores taken systematically over the green, and sent intact and unbroken to the laboratory are much more satisfactory. If the cores are taken to a depth of six inches at least and are unbroken, some idea of the physical condition and root penetration may be obtained, as well as the vertical distribution of nutrients throughout the soil. Shallow cores of one or two inches are not satisfactory and usually do not warrant the expenditure of time and energy in their examination. If chemical tests are to be made in the laboratory, extra care in sampling is warranted.

In sampling fairways, again the rule is to obtain a representative sample. In this case, a composite sample should be made up from samples taken at a number of places over the fairway. The surface soil and subsoil should be sampled separately. sampling depths will vary but for a rough guide, the surface may be sampled to a depth of 6 or 7 inches and the subsoil sample include the next 6 to 8 inches of soil below. The several surface samples are thoroughly mixed and the composite sample taken from the mixture. The subsoil samples are treated the same way.

By having composite samples of both surface and subsoil from the fairway, more complete information can be obtained from the tests and a more reliable interpretation made.

There are several advantages to be derived from making the tests right on the greens. Physical and other factors likely to influence the growth, are more readily noted and considered in relation to the test results. Many more tests can be made. Local variations in soil can be more easily taken care of. Comparisons between tests on different greens or fairways are more conveniently made. Tests may be repeated at intervals during the season with a minimum expenditure of time and labor.

Use of Chemical Test-kits

On the other hand, there are certain disadvantages and limitations in the general use of the chemical tests kits in the field. Simplified as they have been in most cases, these chemical tests are, nevertheless, delicate reactions, involving the production of various colors, or degrees of turbidity, in the test solutions. In field testing, the colors or turbidities are compared with printed charts supplied with the test kits. It is extremely difficult to reproduce on paper the true colors actually obtained with the tests and, as a result interpretation of tests by an inexperienced operator, is not always easy. Since the reactions are so delicate, the least contamination of glassware or reagents used in the tests will also nullify the results. Unless precautions are observed to follow instructions to the letter and keep glassware and chemicals free from contamination, much trouble will be encountered.

Some of the reagents used are also unstable and deteriorate on standing. Tests made with such reagents are not reliable. Certain tests are also subject to interfering substances. For example, in the test for soluble phosphorous, arsenic gives the same color reaction and on golf greens when arsenicals are used for insect and worm eradication, the phosphorus test may give wholly erroneous results. Con-

siderable amounts of ammonia in the soil, also interfere with the test for potassium and where large amounts of compost, organic nitrogen carriers, or ammonium sulphate are being used, the potassium test may give much higher results than it should. The test for nitrates may also be affected by interfering substances and the results may indicate much larger supplies of nitrates than actually exist in the soil.

The above considerations apply more particularly to the short chemical tests made with test kits. In the laboratory, the chemist can better control the freshness and purity of his reagents; he can prepare standards of known concentration for comparison with his tests, and by modification of his methods overcome the effects of otherwise interfering substances in the soil. In these respects, the chemical testing done in the laboratory, is likely to be more satisfactory, than that done on the course by the inexperienced operator with a chemical test kit.

Correlative Studies Needed

In summarizing what has been said about the use of chemical tests in diagnosis of soil problems in general, and golf course soil problems in particular, it must be emphasized again that interpretation of the results in terms of needed treatment is the real problem at the present time. The limitations of the tests themselves have been briefly discussed with regard to the information they can give on the soluble nutrient content of the soil. When used with these limitations in mind, and for the purpose of studying fertility problems of the golf course, chemical tests are undoubtedly of great value. What is needed, as far as conditions in this Province are concerned, is systematic application of chemical tests to golf course soils under various systems of treatment, to determine the relationship between the results of the tests and the actual response of the turf under the different conditions of treatment. When considerable test and response data have been accumulated, and properly correlated, the basis for reliable interpretation will have been established. Only then, will the chemical tests have their greatest usefulness. The need for further research and investigation along such lines is evident. The standards for comparison ordinarily used, in the interpretation of chemical tests on cultivated soils in general agriculture, do not necessarily apply to golf course soil conditions, according to our experience.

BROWN-PATCH*

By J. HUNTER GOODING

It's Better to Use Preventives Than Be Forced to Cure It

THE only genuinely satisfactory method of maintaining greens free from brown-patch lies in preventive rather than in curative measures. By preventive measures, we mean the systematic application of disinfectants to the turf during that portion of the summer when brown-patch infections are likely to occur.

Delaying the application of fungicides until the disease gains a foothold on the greens, can hardly be called brown-patch control.

Once brown-patch fungus has attacked an area of turf, the damage is done. Damage occurs even before we can see the symptoms of the infection on grass. No control measure is effective in so far as that area is concerned. All we can do is to wait a couple of weeks or more until nature restores that section of turf to normal healthy conditions. We all have been slow in realizing that entirely too much emphasis has been laid on the matter of curing brown-patch attacks, and too little attention paid to the far more practical question of preventing attacks.

In 1922, when brown-patch was becoming recognized as one of the major problems of turf maintenance, Lyman Carrier wrote, "The value (of the treatment) lies in prevention rather than cure. After grass has become infected with the fungus nothing can be done for the areas that are hit. Those who have had brown-patch on their greens in the past had better not wait for the disease to appear before beginning treatment."

Professor Carrier's words are just as true today as when they were written 13 years ago.

Brown-patch gives no warning. Like fire, it strikes quickly—and usually at

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