SOIL AND ITS RELATION TO PLANT GROWTH

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THE scientific study of the soil began in the laboratory rather than in the field. As a result soil was not at first regarded as an independent body but more or less as a material which afforded anchorage for plants and a reservoir for the water they needed. Morphological characters such as color, structure, consistency and texture received little or no consideration.

Early in the 19th century scientists began to be interested in the classification of soils. By this time it was evident that the mineral matter of the soil contributed to the nutrition of plants. Observations had shown that soils differed in respect to the growth of different crops upon them, and this centered attention on certain physical aspects of the soil. It attracted the interest of scientists to the processes involved in soil formation and this has led to a much clearer conception of all aspects of the soils as an independent natural body.

As a natural body, soil is the product of a series of reactions, the most important of which we ordinarily include under the broad term of weathering. They include the physical, chemical and biological reaction which are responsible for the breaking down and weathering of rocks and minerals, and the creation, accumulation and destruction of organic matter. Besides these there are a number of agencies which have an indirect effect upon soil formation. These include the type of parent material and the topography and age of the land.

The amount and distribution of precipitation along with temperature will, to a large degree, determine the character and rapidity of the soil forming processes. The climate then becomes the controlling factor and while the parent material may impose some restriction on these processes, the genetic kind of soil arising under any given set of climatic conditions will be the same, regardless of the parent material when the time interval has been sufficiently long and the climatic conditions relatively constant.

Moisture and its movement through the soil is one of the most important of the climatic factors. Whenever the downward movement of water (leaching) exceeds the upward movement (evaporation and transpiration) the soluble products of weathering are leached downward and there tends to be a similar downward movement of colloidal material. This movement tends to remove certain constituents from the surface layer and to concentrate them in the subsurface layer where changes in reaction and physical properties either stop or delay the transported materials. Thus two layers or horizons are formed—a zone of removal at the top and a zone of concentration below. Underneath the latter is the unmodified or only slightly modified parent material. This means then that if we view a soil in cross section, as is possible in a road cut or excavation, there are three distinct layers. These have been designated as the A, B and C horizons. The characteristics of this cross section, called the soil profile, form the basis upon which soils are now classified and mapped.

Upper Soil Most Favorable

In spite of the leaching action of downward moving water the upper or A horizon is ordinarily the most productive and best adapted to cultivation. This is due to the fact that near the surface conditions are most favorable for weathering and the mineral nutrients needed by plants form most readily. Here, too, conditions of air, moisture and food are most favorable for the development of soil organisms which play such an important role in soil formation and plant nutrition. Plant roots reaching into the deeper subsoil absorb nutrients and these find their way into the aerial portions of the plant where they eventually fall back or are carried back to enrich the surface layer. When a part or all of this upper soil layer is lost by erosion, not only the nitrogen, which is held mainly in the organic matter, but much of the more readily available phosphorus and potash is lost as well.

The supply of nitrogen in the soil decreases rapidly from the surface downward due in the main to the rapid decline in organic matter. There is evidence also that in many soils the subsurface layer or B horizon becomes depleted of much of the readily available phosphorus or potash, or both. In this zone roots draw

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Despite the worst blizzard that Ames or Iowa had experienced for several years, approximately 50 greenkeepers and others interested in growing and maintaining fine turf 'mushed in' from Kansas City, Muscatine and other points throughout Iowa, Missouri and South Dakota to attend the annual Iowa State College greenkeepers short course, held March 1-2. Portion of the group attending the course, is shown in the above photo. Prof. S. W. Edgecombe, Extension Horticulturist at ISC, was in charge at the two-day meeting.

heavily on both moisture and mineral nutrients.

As long as the land was occupied by a natural vegetation, which grew up and at the end of its life cycle fell back on the soil from which it sprang, most of the nutrients drawn from the soil were returned to it. Under conditions of this kind plants actually prevented to a certain extent the loss of soluble nutrients by leaching and provided a revolving fund of food upon which each new generation of plants could draw. Upon decomposition of the dead vegetation the constituents released passed again into the soil to serve as food for the next or succeeding generations.

When man appeared on the scene and took over the land for agricultural crops the cycle was broken and too often little or no part of the crop was returned. Gradually the accumulation of nutrients built up by nature becomes so reduced by the removal of crops or by the loss of soil by erosion that nutrients must be added in commercial fertilizers if desirable crop growth is to be obtained.

The determination of whether or not there is an adequacy of plant nutrients, or in other words the determination of readily available nutrients, in the soil is not an easy matter. It is a problem which has occupied the attention of soil chemists for a long time. At first it was thought that if a complete analysis of the soil were made, any deficiencies could be noted and then supplied in the form of fertilizer. Plant nutrients, however, are held in the soil in two forms—a small part in readily soluble form, and a larger part in a difficultly available condition. A complete analysis gives both but does not separate them. Thus little information of value in respect to fertilizer requirements is obtained.

When the inadequacy of complete chemical analyses was recognized, attempts were made to extract the so-called available nutrients using extractants which simulated or imitated the plant. The extracting solutions were ordinarily dilute organic or mineral acids. The results obtained were much more promising, since broad correlations between the amounts extracted and the crop response to added elements were secured. The correlations, however, were not specific enough to permit them to be used to indicate the immediate fertilizer requirements.

Testing Gives Useful Information

In recent years the interest in soil testing by chemical means has been revived and much progress has been made. This has been possible because of our increased knowledge of the forms in which plant nutrients exist in the soil, the availability of these to plants and the means by which such forms may be extracted. When the tests have been calibrated for the particular soils of any given area much useful information may be obtained through their use. The proper interpretation of such tests, however, requires a knowledge of the fundamentals involved, and a background of experience which permits the consideration of the factors concerned.

The adequacy or inadequacy of nutrient elements in the soil will be reflected in the type of plant growth. Whenever there is an ample supply of nutrients to meet the requirements of the plants growing under any particular climatic environment normal plant growth may be expected. If there is a deficiency in one or more elements, growth is not normal and in case the inadequacy is great enough, it is evidenced by the occurrence of deficiency diseases. In the case of feed crops such deficiencies may be the cause of deficiency diseases in humans and livestock, when

consumed to the exclusion of food crops grown on normal soils.

Such deficiencies may not be limited to the elements commonly supplied in commercial fertilizers, i.e., nitrogen, phosphorus, potash, and lime but may also include some of those generally referred to as trace or rare elements such as copper, zinc, manganese, cobalt and boron. It has been shown, for instance, that the black heart of sugar beets has been caused by deficiencies of boron. In some areas deficiencies of the same element, while not producing deficiency diseases in other crops, has restricted growth to a greater or lesser degree. The reason for designating these elements as "trace" elements is that only very small quantities are needed to meet the nutritional requirement of plants.

Golf Gives Most Soil Problems

Many of the soil problems common to agriculture are involved in the management and maintenance of golf courses. Here we have essentially a grassland agriculture but with certain special features not commonly involved in ordinary grass culture. On the fairways the soil, in the main, is as it was when taken over from other types of agriculture. All the common fertility problems are involved. It approaches most nearly the conditions met under grazing, since the nutrients removed from the soil are largely returned to it. The grass clippings fall back on the soil and much of the nutrient content eventually is available for plant use. Under such conditions one must make sure that there are ample amounts of phosphate and potash present in available form. These will then become less rapidly depleted than under a system which requires the removal of the crop. Phosphorus tends to form insoluble and unavailable compounds and this necessitates the application of a new supply in an available form. The primary consideration of fairway fertilization relates to an adequate use of nitrogen fertilizer. Unlike phosphorus and potash, nitrogen is not fixed in the soil and water moving through the soil leaches away any not used by the plants. Some is lost by volitilization into the air. The rapidity of the loss by leaching is related to the amount of percolation—the larger the amount of water percolating through the soil the more rapidly is the soluble nitrogen removed.

On the greens a different situation exists. In the first place the soil is especially prepared and fertilized so that drainage, texture and the supply of nutrients are optimum. Moisture is added as needed and the grass is regularly fed with fertilizer. In spite of this, far greater difficulties generally are encountered on the greens than on the fairways. A part of the trouble is due to the fact that special grasses such as the bents are used. The conditions under which they grow are very often far different from those under which they originated and grew naturally. Besides this the grass is kept cut extremely short and this offers the plants only a limited opportunity for the elaboration and storage of food materials. As such conditions are far from optimum the plants may be weakened or develop abnormally and not be able to resist diseases which attack them as well as they would in their natural habitat and under normal conditions of growth. There is the possibility that special fertilizer treatments may have some effect on the development of diseases by improving growth conditions and growth to such an extent that the effect

Group attending the eleventh annual short course in turf management held at Rutgers University, New Brunswick, N. J., February 13-18, is shown above. Approximately 70 attended the course, 68 of whom received certificates for faithful attendance throughout the entire week. The attendance at the course showed the following distribution from a geographical standpoint: New Jersey, 46; New York, 12; Massachusetts, 5; Pennsylvania, 4; Ohio, 1. Dr. Howard B. Sprague and Prof. Frank Helyar, director of short courses at Rutgers, were in charge of the course.

Ohio State U. golf course at Columbus, brought in $20,000 in playing fees, despite low rates. The Buckeyes' golf establishment eventually will have 36 holes of such character that the university hopes to be host to the National Intercollegiate golf championship within the next three years.

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of the disease will be lessened.

More and more land each year is being taken out of crop production and given over to golf courses. They are essentially parts of our agricultural industry which, like other parts of the same industry, has a great variety of problems peculiar to itself. These problems offer wide opportunities for research and in such research both the greenkeeper and scientist are involved. A satisfactory solution of most of the problems can be attained only through the cooperative efforts of these two individuals.

200 Attend Massachusetts Recreational Conference

THE job of getting and keeping a golf course in fine condition came in for the most attention at the sixth annual Recreational Conference held at Massachusetts State College, March 10-12. Over 200 greenkeepers and those interested in turf for recreational areas, attended the sessions of the conference. Six organizations, the Greenkeeping Supts. Assn., the New England, Rhode Island, Connecticut, Northeastern New York and New Jersey Associations of superintendents were represented at the meeting.

The initial event on the program was the graduation exercises for those attending the 1939 MSC greenkeepers short course. Roland H. Verbeck, director of short courses at MSC, presented the certificates. Gordon Haberkorn, Somerset Ridge CC, St. Paul, Minn., got the educational portion of the program under way with a paper on "Appreciation of Depreciation," which brought out the high cost clubs were having to pay for using worn or outmoded maintenance equipment. Other speakers at the first day's proceedings were Anthony J. Sperandio, Leicester, Mass.; Fred J. Sievers, MSC agricultural experiment station director; Myron S. Hazen, American Agricultural Chemical Co.; Joseph Ryan, retired president of the GSA; J. A. Gormley, GSA vice-pres.; Prof. Lawrence S. Dickinson, agronomy dept., MSC; Dr. O. J. Noer, Milwaukee Sewerage Commission; L. D. Gray, American Potash Institute.

The first day's program was concluded with the showing of two reels of movie film, and numerous colored lantern slides, by Prof. Dickinson. The pictures were taken during his tours in 1938, with a camera presented him a year ago by the alumni of the Massachusetts State College winter schools.

Dr. Hugh P. Baker, president, MSC, opened the Saturday program, speaking on "Cheering Prospects." The strong point Baker made in his talk was that "as long as we have the spirit of play and relaxation, there is little to be feared of political uprisings, or war scares." Dr. James Tyson, Michigan State College agronomist, was the next speaker, giving his observations on the influence of soils and climatic conditions upon the suitability of grasses for golfing areas.

Treat Presented Gavel

H. T. Islieb, Spring Brook CC, Morristown, N. J.; Wm. Mitchell, New London (N. H.) CC; Charles Parker, Wianno GC, Osterville, Mass.; Guy C. West, president of the R. I. Greenkeepers Club; and Dr. J. DeFrance, R. I. Experiment Station, also spoke on Saturday's educational program. During a program sponsored by the Greenkeepers Club of New England, celebrating the 15th anniverary of the founding of the club, a gavel, as a token of esteem, was presented Carlton E. Treat. Treat was the third president of the New England club, and is now maintenance manager of the Montclair GC in N. J. For the past few winters he has been assisting Prof. Dickinson in class work with the advanced school.

Edward Casey, of Westchester Co., N. Y., golf district, was elected 1939 president of the Massachusetts winter school Alumni assn. at the annual banquet Saturday evening.

The annual "Experts on Trial", held Sunday p. m., was the final event on the program. Dr. James Tyson served as "Chief Justice," and his benchmen were instructors Davis, Eisenmenger, Gunness, and Markusson of MSC, along with T. C. Longnecker, N. J. Experiment Station, Chas. Halowell, Penn State, and O. J. Noer. Carlton Treat was prosecutor and interrogator.

Much interest was shown in the annual course equipment and supply exhibition held in connection with the conference, and the report was that considerable business was transacted.