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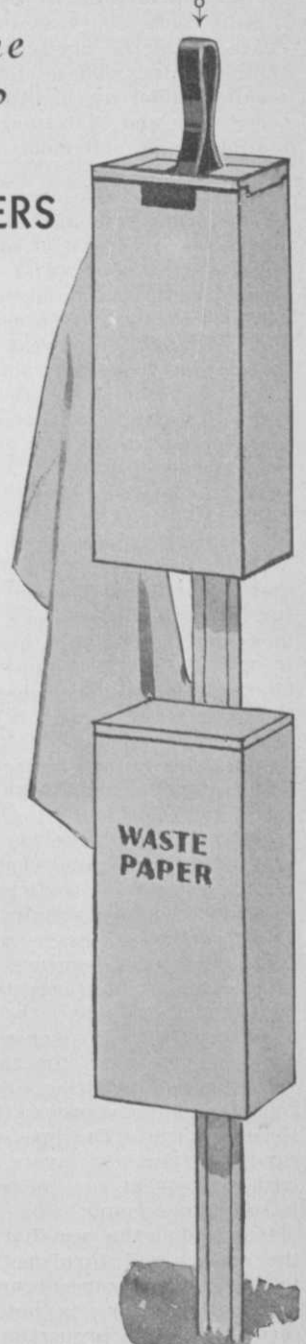

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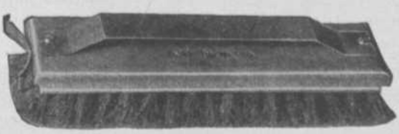

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of horizons is collectively known as the "Soil Profile."

Wide Variations in Soil Profiles.

Soils show marked differences in the character of the horizons which make up their profiles. These differences are the result of different conditions of climate, of topography and of drainage during the formation of the soil from its parent material.

Consider the case of a soil adjacent to a stream subject to annual overflow; it receives yearly deposit of soil material dropped from the flood water. Before this deposited material has opportunity to undergo much change a fresh deposition is made. This continues from year to year. A soil formed under such conditions will show little variation from the surface downward. It may be almost entirely uniform to a depth of three feet or more.

In marked contrast is the soil on the upland far removed from any possible deposition by flood water. It has been in place for possibly thousands of years. Through all this long period of time it has been undergoing slow changes. The soil-forming processes have been continually remodeling it. Finally there results a soil in which there is a marked gradation in physical and chemical characteristics from the surface downward. A definite soil profile is developed in which there are several distinct layers of horizons differing in many ways, especially in thickness, textures, and color, and often in reaction.

Upland soils of the humid regions generally tend to be somewhat stratified as to texture or size of particles. Their upper or surface horizons usually contain a greater proportion of larger particles than do the lower or subsurface horizons. The process of leaching, especially in old soils, has tended to move the finer particles downward with the consequent formation of layers made up for the most part of very fine soil particles. Such layers offer considerable resistance to the flow of water through them. The opposite condition of sandy or gravelly layers in the subsoil, with consequent ease of water movement, is sometimes found.

It is seldom the case that the character of the surface soil furnishes a reliable clue to the kind of sub-soil underneath. The drainage engineer is not so much concerned with the properties of the surface horizons as he is with those of the subsurface. It is particularly important to him to know whether or not any of the horizons of the sub-soil are only slowly permeable to water. If they are, he must know the exact location of these impervious horizons with respect to their distance below the surface.

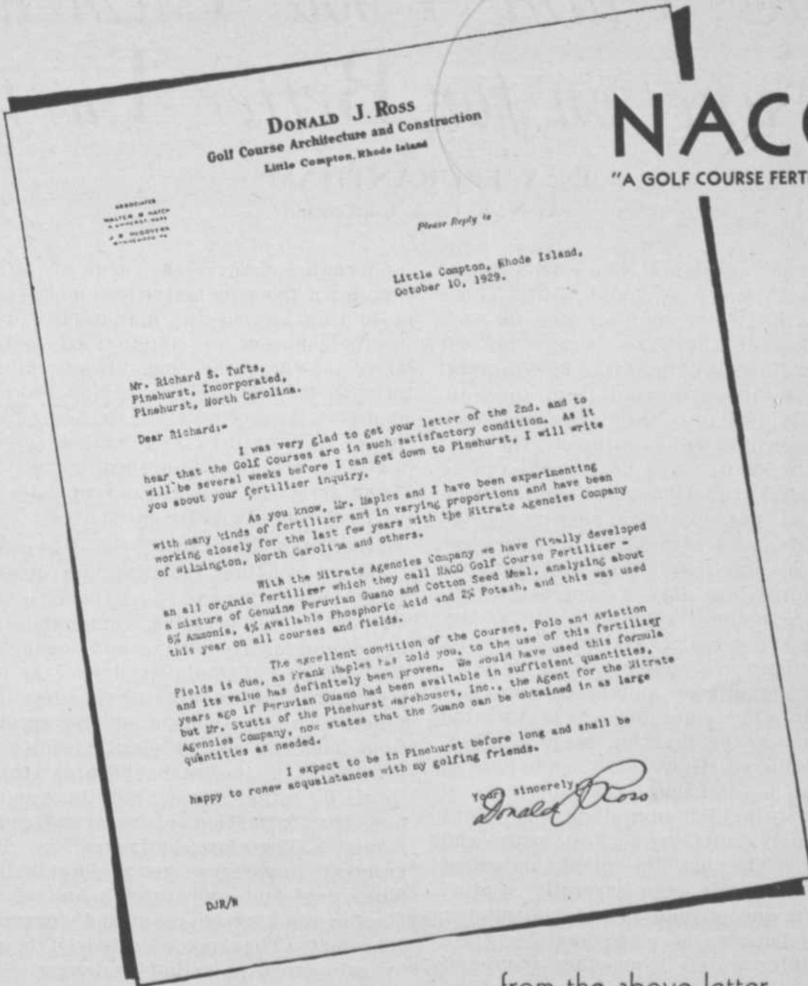
He also needs a clear picture of the nature and texture of the soil material in these impervious horizons in order to know how to proceed to overcome this condition. A lack of knowledge of these two points might result in so placing lines of tile in the sub-soil as to render them ineffective.

A determination of the percentages of the various sized particles which constitute a soil defines its texture. Soil particles vary in size from mere specks, invisible with the most powerful microscope, to those which are large enough to be seen with the unaided eye. The physical properties of any soil horizon are determined largely by the size, arrangement, and relative proportion of these different sized particles in it. Of particular interest to the drainage engineer is the amount of extremely fine or "colloidal" material present. He is especially interested in this because of its marked effect on the total surface area of the soil particles which in turf effects the movement of water through the soil.

As the number of fine particles in a given weight of soil is increased the combined surface area of the soil particles increases also, but not in the same proportion. If the sizes of particles is decreased to one tenth the previous size, the total number present in a given weight of soil is increased one thousand times. At the same time their total surface is ten times as great. It is this latter which is of most significance from the drainage standpoint.

If all the particles contained in an acre of soil to a six inch depth had diameters of one-twenty-fifth of an inch the total surface area of the soil particles in the acre would be less than five hundred acres. On the other hand if the particles all had diameters of one-ten-thousandth of this amount the total internal surface area in the acre would be five million acres. In this latter case the particles would tend to stick together with a consequent slowing up of the rate of movement of water through the soil. Many soils contain a considerable proportion of particles smaller than those last mentioned, especially in their sub-soil horizons.

These fine colloidal particles tend to decrease the size of the drainage channels through the soil.



DONALD J. ROSS
Golf Course Architecture and Construction
Little Compton, Rhode Island

Please Reply to

Little Compton, Rhode Island,
October 10, 1929.

Mr. Richard S. Tufts,
Pinehurst, Incorporated,
Pinehurst, North Carolina.

Dear Richard:-

I was very glad to get your letter of the 2nd. and to hear that the Golf Courses are in such satisfactory condition. As it will be several weeks before I can get down to Pinehurst, I will write you about your fertilizer inquiry.

As you know, Mr. Maples and I have been experimenting with many kinds of fertilizer and in varying proportions and have been working closely for the last few years with the Nitrate Agencies Company of Wilmington, North Carolina and others.

With the Nitrate Agencies Company we have finally developed an all organic fertilizer which they call NACO Golf Course Fertilizer - a mixture of Genuine Peruvian Guano and Cotton Seed Meal, analyzing about 8% Ammonia, 4% Available Phosphoric Acid and 2% Potash, and this was used this year on all courses and fields.

The excellent condition of the Courses, Polo and Aviation Fields is due, as Frank Maples has told you, to the use of this fertilizer and its value has definitely been proven. We would have used this formula years ago if Peruvian Guano had been available in sufficient quantities, but Mr. Stutts of the Pinehurst Warehouses, Inc., the Agent for the Nitrate Agencies Company, now states that the Guano can be obtained in as large quantities as needed.

I expect to be in Pinehurst before long and shall be happy to renew acquaintances with my golfing friends.

Yours sincerely,
Donald J. Ross

DJR/M

NACO

"A GOLF COURSE FERTILIZER"

from the above letter . . .

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How Plant Food Elements Function for Better Turf

By A. E. GRANTHAM*
(At N. A. G. A. Convention)

THE food of plants comes from three sources, water, air and soil. Those from the water and air are in such abundance that they are always present for the full needs of plants. The mineral elements, or those derived from the soil, may be divided into three classes; first, the non-essential, which, although they are absorbed by plants, are not considered to have a vital function, such as silicon, sodium and possibly manganese; second, the essential and abundant—in this class are iron, calcium, magnesium and sulphur; and the third class may be considered critical, which includes nitrogen, phosphorus, potassium and possibly sulphur. More recent investigations, however, lead us to believe that manganese and magnesium are deficient in some soils and are performing a more important function than was formerly considered. However, the purpose of this paper is to discuss the functions of the three principal ingredients of plant food; namely, nitrogen, phosphorus and potassium. The use the plant makes of these elements has been carefully studied by chemists and physiologists for a number of years. The use of plant food by grass does not differ widely from other groups of plants, although little direct investigational work has been carried on along this line —the attention of the agricultural experiment stations in the past dealing largely with field grown crops.

The plant cell is the unit of growth. The principle of life in the cell is protoplasm. It is the laboratory in which all the changes of the plant, take place. The vital processes of plants—assimilation, translocation, respiration and metabolism, are essentially chemical in character. Protoplasm is made up of complex compounds, which differ from non-living matter; first in chemical composition; second, its power of waste, repair and growth; third, its reproductive power. Living matter is constantly undergoing change—the result of the breaking down from its activities and by making good this loss by the manufacture of new protoplasm out of simple food materials. Here is where the elements of plant food play their part. With surplus protoplasm it makes new cells, more tissue and organisms. It produces new masses of living matter contained in the seed or fruit, which when detached from the parent mass eventually begin a separate existence.

Nitrogen's Function.

Let us consider the functions of each of these three elements. Nitrogen is a constituent of all proteins, compounds which are found as the active component of all protoplasm. Protein is from the Greek meaning preeminence, or of first importance. The protoplasm of the green portions (leaves) of the plant permits protosynthesis of the carbohydrates, the synthesis of other tissue building materials and the formation of reserve food substance. Therefore, nitrogen is of the greatest importance to a plant. It promotes leaf and stem growth and gives the plant a dark green color and vigorous appearance. The lack of nitrogen is shown by pale green or yellowish leaves. Excess nitrogen gives rank growth and retards the ripening process. Excess nitrogen produces a soft plant tissue, due to the weak cell wall, which is in turn subject to plant diseases. If we turn to field crops, on which most studies have been made with reference to nutrition, we find that wheat and oats, when supplied with heavy applications of nitrogen, have a weak stalk growth, which makes the plants subject to lodging and to such diseases as rust and others. Wheat and oats belong to the grass family, although they are annuals. The same results are found with such crops as tobacco. While excess nitrogen produces large plants and abundant leafage, the tissues are not firm and fail to mature proper-

Director, Soil Service Bureau, V.—C. Chemical Corp.

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ly and the plant is much subject to disease. In the early growth of plants nitrogen is largely in the leaves—later it is transferred to the seed.

Part Phosphorus Plays.

The second element, phosphorus, while directly essential to plant growth, the effect is not so visible in the general appearance or color. Available phosphorus in early growth stimulates root development, an important feature of grass growth. It hastens the development of adventitious buds or rootlets on plants that reproduce themselves by tillers, root-stalks or stolons. Most plants send out a secondary set of rootlets after those that have been produced directly with the seed. It is with these secondary rootlets that the phosphoric acid seems to have very active effect. It is well known that wheat, seeded in the fall and fertilized with phosphates, makes a much better root system and is less subject to action of frost during the winter than wheat not so treated. This is evidence that more extensive root system is produced by the phosphates. Phosphorus hastens maturity. In other words, it acts in the opposite way from nitrogen and when applied with nitrogen tends to counteract the effects of over-feeding of nitrogen. Phosphorus is indispensable to plant growth, as it is the essential constituent of the nucleus of the cell. It is said to determine the rate of chemical changes in the cell. Large amounts of phosphates are taken up by the plant in its early stages of growth. Later it is translocated to the seed or grain, which contains large amounts of phosphorus. Since phosphorus is a constituent of every plant cell, and cells form the tissues of the plant, it must be looked upon as one of the very important elements of plant food. It has been remarked that since grass on the golf course or green is not grown for its seed, then why use phosphorus. It should be kept in mind that phosphates are necessary to the growth of all plants and whether the plant is deprived of the opportunity to produce seed or not, the living tissues (the blades of the grass) must have phosphorus.

It is generally stated that potassium forms the sugars and starch in plants. We know that potatoes, beets and sugar cane require and use large amounts of potash. However, all plants require potassium, as it is needed in the cell sap to effect necessary changes in translocation of plant food. Plumpness and size in tubers and grains are dependent on plenty of available potassium. Potash hungry plants are more subject to disease. This is particularly noted in corn, tobacco and cotton, all of which are subject to particular diseases when the soil does not furnish enough potash. It is also noted in general crops, that excess potash retards maturity. This point may be of value in the maintenance and keeping of grass more luxuriant during the season. This is probably due to the fact that potash maintains the tone and vigor of the plant. The scarcity of potash is not shown so markedly in the case of plants, except by rather retarded growth and the tendency to be more susceptible to disease.

Each of the three elements, therefore, play a special part in the growth of all plant life. While it is true some plants use more of one element than another, nevertheless nitrogen, phosphorus and potassium are found as a constituent of all living plant tissues.

Golf's Artificial Conditions.

The growing of grass under golf conditions, particularly on greens, presents a problem unlike most in the agricultural field. Until very recently little experimental work bearing directly on the fertilizer practice for greens has been conducted. Of course, for many years the agricultural experiment stations and the U. S. Department of Agriculture have carefully tested out the fertilizer requirements, particularly the functions of the various plant food elements, nitrogen, phosphorus and potassium in producing the various crops. Under such conditions it is now pretty well known how each of these react in the growing of the crop, and particularly the part they seem to play under various conditions of soil and at various stages of plant growth.

On the golf course we have very artificial conditions. The plant cannot be cultivated and on greens it is cut close, perhaps every other day in the growing season. It is heavily watered and, to maintain the proper physical condition on the surface, repeated additions of compost and sand are made. Heavy watering almost daily in hot weather produces a condition of soil tilth or structure that may be favorable or not to the best growth of grass, particularly since this greatly depends on the drainage and aeration of the soil. Therefore, there are no other conditions quite comparable. It is true with pasture environment, where cattle graze regularly, we have a condition more or less similar. However, the trampl-

ing action of cattle on grass is far different from the effect of footprints made by human beings. Further, the treading of the grass while the soil is quite wet furnishes another factor that is not at all favorable.

These are some of the conditions confronting the greenkeeper. At the same time the continued clipping of the grass removes plant food and in time the soil is bound to be depleted of one or more elements. The practice in many quarters has been based on the idea that grass needs nitrogen chiefly, if not entirely. This has resulted in repeated applications of nitrogen in the form of sulphate of ammonia or other quickly assimilable nitrogen carriers.

Coping with Clover.

Then too, the soil on greens particularly is being constantly modified, due to the additions of sand, compost, etc. Most soils in the United States are deficient in phosphorus. In other words, under normal field conditions there is not enough available phosphorus to give a full growth to many crops. This should be borne in mind in building greens, that sufficient fertilizer, carrying all three elements of plant food, particularly phosphates and potash, should be applied to the soil before the greens are seeded. The same applies to fairways. The reason for the objection to the use of phosphates and potash in fertilizer often lies in the idea that these ingredients of plant food promote the growth of clover. It is probably true on soils hungry for these elements that clover will come in to some extent. However, the association of clovers with bluegrass is one that is constantly changing. Where land is made suitable to grow clover, bluegrass is likely to follow rather than the reverse. The best bluegrass lands of Kentucky contain many times as much phosphorus as they do nitrogen and these are almost pure bluegrass lands. In other parts of the country, western Virginia, southern Wisconsin and northern Illinois, we find some of the most typical bluegrass, but it is noticeable that they are on soils that are rich in phosphates and potash. It is a noticeable fact that stands of legumes, such as sweet clover, alfalfa and even Japanese clover, are followed by bluegrass, which tends eventually to crowd them out. The nitrogen gathered by the legumes seems to favor the spreading of the true grasses. Some of the best stands of bluegrass I have ever seen followed, without seeding, fields of alfalfa where the alfalfa was gradually crowded out by the encroachment of the grass. Recent experiments conducted at the New Jersey Experiment station offer some very good evidence along this line. These tests have been running for several years. It was found there that the plats receiving a complete fertilizer showed the least amount of white clover, the most white clover appearing on the check plat. Likewise, tests with lime, against which considerable prejudice has been aroused in recent years, showed that lime did not increase weeds where ample plant food was added in addition, and it was also noted that lime plus fertilizer gave the best and most uniform growth. These points are merely brought out to show that perhaps there is not as much danger to be feared from the use of fertilizers carrying phosphates and potash, and perhaps the use of lime, as is generally considered. It is true that bent grass is largely used on greens proper. The bents in their native states grow on soils that have a good supply of potash, bluegrass particularly where there are abundant phosphates.

Cites Fertilizer Experiments.

During the past two years The National Fertilizer association has conducted a large number of tests on top-dressing pasture grasses in various parts of the eastern states and New England. These tests consisted of comparing results secured with the application of phosphates, potash and phosphates, and nitrogen, phosphates and potash. Most of these pastures had been down for years and many of them were on native foundation. It is interesting to note that while the complete fertilizer gave the greatest returns in growth of grass, nevertheless phosphate and potash combined made as much yield as the nitrogen. In other words, phosphates produced 341 pounds, potash 302 pounds and nitrogen alone 650 pounds. (Of further interest was the fact that the plat receiving all three elements of plant food maintained a more vigorous growth during the hot summer weather than where single elements were

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used. The fact that potash tends to delay maturity when applied in liberal amounts may have some bearing on this point. In these tests it was found that phosphates and potash did increase the amount of clover, but where nitrogen was applied in addition the grass was further stimulated and became a very strong competitor of the clover. Subsequently it may appear that, due to the greater growth of clover, the true grasses will grow more luxuriantly as has been observed elsewhere.

It is worth while remembering that other plants, such as lettuce, spinach and plants grown for their leafy tops are fertilized not only with nitrogen, but with large amounts of phosphates and potash also. With grass, we have been trying to keep it growing in many cases by the use of nitrogen alone. Some greenkeepers have found already that they can well afford to apply some complete fertilizer to greens, even during the summer if applied in very small quantities along with the compost that is usually put on. Of course, this has to be done with care, but where greens seem to be lacking vigor and tone undoubtedly fertilizer carrying phosphates and potash will be of much benefit.

Advises Early Application.

Where complete fertilizers are applied it seems from all evidence obtainable at present that it should be applied very early in the growing season, as soon as grass shows signs of renewed growth in the spring. The test conducted by The National Fertilizer association, referred to above, showed that where the top-dressing was made early that there was twice as much grass produced as where it was applied 30 to 50 days later. The early application of top-dressing means more vigorous and better turf earlier in the season and a very much better established grass during the late summer. Golf courses that formerly applied fertilizers in the usual manner--after the grass is well established —have found upon changing methods and applying the fertilizer very early that they have received a much more permanent growth of grass.

Much of our knowledge of growing grass is empirical. What we need is some definite experimental work to establish the factors most favorable to growing grass under the very artificial conditions now obtaining on greens and even on fairways. Some of the lines of work that might be undertaken are a study of the root system development as effected by the repeated cutting. Does frequent cutting weaken or tend to strengthen the root system? Does the heavy watering during the summer keep the feeding roots near the surface or does it cause them to go down? These factors have a definite relation to the permanency of the turf. Further, a histological study of the cell structure of grass should be made under various fertilizer treatments. Do repeated applications of nitrogen weaken or strengthen the cell wall? This information is of value in determining the relation of fertilizer treatment to resistance to disease and attacks of brown-patch.

PREMIER'S NEW LINEUP

NORTH AMERICAN CAR CORP. has acquired the Live Poultry Transit Co., which included the Premier Poultry Manure Co., a subsidiary. The new officers of the Premier Poultry Manure Co. are: L. H. S. Roblee, pres.; E. D. Brigham, vice-pres.; G. A. Johnson, secy.-treas.

In the course of this merger the Premier Poultry Manure Co. obtained an increase in their raw poultry manure, which will increase the finished product production about 25%. However, with this increase the mechanical condition remains the same.