# How to Fertilize GOLF TURF

# By O. J. NOER\*

**B**ARNYARD manure, now displaced by more concentrated materials, was once the standard golf turf fertilizer. Its use presented few problems in turf maintenance. Manure still has its staunch supporters who believe that a return to its general use would be the Moses to lead golf clubs out of all turf management troubles.

With manure the procedure was simple and very little skill or knowledge was required, because there was little danger of producing bad effects. Results were satisfactory because golfers were easily satisfied. During this era fairway applications were made in the late fall after play ceased, and any remaining trash was removed in the spring before play was resumed. On greens compost rich in manure was prepared and used in top-dressing mixtures. Many supplied some or all the nutrient elements required for growth, the low content of soluble material prevented direct turf injury for burning, and minimized the danger of forcing rapid lush growth. Turf improvement was necessarily slow, play on fairways was impossible following its application, and there was also the possibility of introducing troublesome weeds, besides the danger of stimulating clover due to high proportion of potash.

Although low in actual plant food, manure at the moderate rate of 10 tons per acre, supplied 100 pounds actual nitrogen and potash and about half as much phosphoric acid. Failure to appreciate this fact accounted for early disappointments following attempts to duplicate results with a few hundred pounds per acre of fertilizer even though it contained 6 to 12 per cent of nitrogen and what seemed adequate quantities of other elements. Where other fertilizers were used on fairways in amounts sufficient to satisfy soil deficiencies, superior results have been obtained at less expense.

Where manure of good quality is obtainable, its use will continue as an ingredient of the compost included in top-dressing mixtures, but in some metropolitan dis-

\*N. A. G. A. convention address.

tricts, manure will compel the use of humus substitutes for improvement of physical soil condition supplemented with fertilizer to supply needed plant food.

# Lesson of the Acid Era

The use of ammonium sulphate started about 15 years ago, and gathered momentum until the disastrous season of 1928. Fairways received scant attention until recent years, so applications were confined largely to greens. Sulphate produced startling results and its virtues were preached at every gathering of greenkeepers and club officials charged with turf maintenance. Besides its effects in deepening green color and producing rapid growth, both almost immediately evident, there was a notable decrease in clover and weeds, attributed entirely to the increased soil acidity induced by ammonium sulphate. This period may be termed the acid era in turf maintenance.

The immediate effect of wholesale turf loss during the humid hot season of 1928 was general and unwarranted condemnation of ammonium sulphate. The zeal to increase soil acidity encouraged too generous use of sulphate, and turf loss resulted from too rapid growth with attendant weak soft leaves caused by the large quantities of immediately available nitrogen. In some instances soils either become too acid, or were depleted in the so-called basic elements, calcium and magnesium.

When reason finally prevailed, it was realized that a climax had been reached and that the trouble was actually a blessing in disguise. To overcome future disaster the use of sulphate was not necessarily abandoned, but mid-summer rates were reduced so as not to unduly force rapid growth. Soils were tested for acidity and where found too acid lime was applied to correct the condition, but at minimum rates so as not to encourage clover. The acid era in turf maintenance ended when it was realized that the pendulum had swung too far.

At present it is believed that first consideration must be given to practices which will insure development and main-

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tenance of sturdy dense turf. Alhough an acid soil is desirable as an aid to further suppression of clover seed and weeds, it should not develop to the point where the turf grasses suffer, for weeds flourish in thin turf areas devoid of grass.

Fertilization has become one of the most important factors in golf turf management. It is the surest method of improving poor turf, but it is folly to expect a single application to immediately transform such grass into dense sod. While courage may be required to embark upon a definite program, the reward is desirable coverage in reasonable time for grasses spread by means of underground rhyzomes or surface runners in the presence of moisture and ample plant food. Regular feeding of good turf is equally important to prevent deterioration and subsequent weed infestation.

The success of any program depends upon selection of a suitable fertilizer, uniform application at the proper season, using rates sufficient to satisfy soil deficiencies without unduly forcing rapid growth. Besides being familiar with the properties of the various classes of fertilizers, intelligent selection of the right fertilizer requires a thorough knowledge of turf nutrient requirements, an understanding of the soil as a source of plant food.

Of the 80 odd known chemical elements, grasses use 10 in appreciable quantities and of these seven are obtained from the soll: iron, sulphur, magnesium, calcium, nitrogen, phosphorus, and potassium. Recent investigations indicate that minute amounts of certain rarer soil elements are also essential for growth. Ordinarily soil deficiencies are confined to one or more of the elements, nitrogen, phosphorus, and potassium.

Occasionally lack of soluble magnesium, calcium, and the rarer elements inhibit normal growth. Magnesium and calcium deficiencies are most apt to occur on strongly acid soils. Since too much acidity is detrimental to best growth, its correc-



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tion by the moderate use of lime eliminates these deficiencies, particularly if lime containing some magnesium is used. Deficiencies in the rare elements are confined to unusual soils, the barren sands of the Coastal Plains region, and soils of a highly calcareous nature, but are seldom found in the north.

Since nitrogen, phosphorus, and potassium are the three important fertilizer constituents, an understanding of their functions, together with their occurrence and behavior in the soil, is most essential

# Nitrogen Is Key Element

Nitrogen is most important, and on established turf is the key to success. Besides being responsible for dark green color and active vegetative growth, it is the element which encourages grass to spread and thus form turf free from cuppy lies. Contrary to general belief, nitrogen favors a dense root structure, and is not the sole cause for shallow root systems. Over-watering, extremely tight and compact soil, excessive soil acidity, and on fairways too close cutting are more apt to be the cause.

Need for nitrogen is easily detected. Brown color, slow growth, and failure of the turf to spread are sure indications. Most infestation and serious clover invasion are also unmistakable signs of need for nitrogen.

The soil supply of nitrogen is found in the dark colored humus or organic matter, hence dark colored soils have more nitrogen than those of light color. This insoluble nitrogen is converted into usable forms by the soil micro-organisms. Even dark colored soils often respond to applications of nitrogen. In these cases the soil humus exists in forms which resist further decompositions by the soil organisms.

Aside from calcium, leaching losses are confined almost entirely to nitrogen, because nitrates, the ultimate product formed by soil bacteria, move freely in the soil water. Under certain conditions additional losses may result from de-nitrification. Greatest losses naturally occur in sandy soils. To minimize loss, regular nitrogen feeding in quantities just sufficient to satisfy the turf's demand is the sensible practice.

# Phosphorus Hurries Root Growth

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From the standpoint of grass, its stimulating effect on root development is of greatest importance. Phosphorus stimulates rapid initial root development, and enables weaker seedlings to compete with healthier plants so a more uniform stand of grass is obtained.

The response from phosphorus applications is less marked on established turf, because the soil supply of available phosphorus is constantly augmented by decay of clippings. Fixation of applied soluble phosphorus near the surface is an added reason. Where results are obtained effects are most noticeable, with the approach of warmer mid-summer, in the ability of turf to withstand unfavorable temperatures.

Phosphorus occurs in the mineral soil fraction, and is most abundant in the finer particles. Hence loams and clay soils contain more phosphorus than sands. Soluble phosphates are precipitated in the soil so this element does not leach out in the drainage waters. Resolution occurs to satisfy the turf's need for this element.

On fairways where soil deficiencies are acute, generous initial applications which need not be repeated for several years, rather than light yearly applications, may prove best. There is no danger of appreciable loss from leaching and deeper movement into the soil may occur.

The generous use of phosphates on new seedings is sound practice, because the phosphorus can be worked into the deeper soil by mechanical means.

Potassium functions mainly as an aid in the formation and translocation of socalled carbohydrates—sugar, starch, and cellulose. Clovers have a high potassium requirement, so too generous use of potash should be avoided.

# Potassium Usually on Hand

Like phosphorus, potassium exists in the mineral particles and is very abundant in the finer fraction. There are 20,000 to 40,-000 pounds actual potash in the surface soil of heavy soils. These soils rarely respond to the use of potash, especially if clippings are not removed. Of the three fertilizer elements next to nitrogen, potassium is most abundant in clippings. Upon decay this potash is released for further use and unlike nitrogen, potassium does not leach readily. Any applied soluble potash is taken up and held by the silt and clay particles so applications sufficient for several years can be made on fairways without danger of loss.

The only fairway soils on which need for potassium should be questioned are the poorer sands, mucks, and peats.

# Lime Not Always Bad

The belief that lime, because of its tendency to increase clover and weeds, should never be used on turf is no longer tenable and its judicious use is now recommended. The effects of lime are most noticeable in mid-summer in the ability of turf to withstand drought. Lime also tends to improve the structure of acid clay soils by promoting granulation and thus improves water-holding capacity, and tends to overcome localized drying of soil on greens.

The amount of lime required depends upon degree of soil acidity, kind of soil and variety of grass. Except for limeloving Kentucky bluegrass, need for lime is probably confined to soils of moderate to strong acidity. The coarser textured sands and sandy loams require less lime than the fine textured loams, silts and clays of equal degree of acidity. Fescues and bents tolerate more acidity than Kentucky bluegrass, so they require less lime and its use should be confined to the more acid soils.

Yearly applications of lime are seldom needed. On fairways it is better practice to use lime every two to four years to minimize the danger of encouraging clover. In some districts the use of a material containing some magnesium may be advisable to eliminate any possibility of magnesium deficiency.

There are a large number of different fertilizer materials. They may contain one or more of the three important elements, and their plant food contents very widely. The rate at which plant foods become available differs and the indirect effects of different fertilizers upon the soil are important. Fortunately they can be grouped into broad classes, which is an aid in the selection of the fertilizer which will produce desired results.

As the name implies, the organics are of plant or animal origin and include such materials as blood, bone, tankage, castor pomace, and natural manures. The nitrogen in its original form cannot be taken up by growing plants. The same processes which convert soil nitrogen into available form are responsible for decomposition of organic fertilizers. Some such as blood and tankage break down rapidly, so effects are not lasting. Others such as bone release nitrogen slowly and hence provide for longer feeding. Water soluble organic nitrogen is almost immediately available, hence, so far as growth effects are concerned, such materials should be classed with ammonium sulphate.

True organics are less apt to burn than water soluble fertilizers, but even the organics vary in this respect. Those which contain small amounts of soluble material and break down slowly are least apt to burn.

Organics are without appreciable effect on soil reaction, although bone, because of the lime it contains, has a slight tendency to reduce acidity.

The ammonia containing nitrogen fertilizers include sulphate of ammonia and the various ammonium phosphates. They are water soluble, hence quick acting, but effects are seldom long lasting. Because the ammonia is temporarily held by the silt and clay particles they do not leach as rapidly as materials containing nitrate nitrogen.

All tend to increase soil acidity. The effect is most pronounced with ammonium sulphate. If used continuously, they tend to lose their effectiveness, but this can be restored by the moderate use of lime.

Due to complete solubility all tend to burn the turf, so slight rates of application are the rule.

The third group of nitrogen containing materials-includes all those in which the nitrogen occurs as nitrates. Sodium nitrate, or Chile Salt-Peter, and Calcium nitrate are the principal fertilizers in this group. Both are water soluble and hence apt to burn the grass. They leach readily, tend to reduce soil acidity. Since they do not suppress weeds and favor growth of the coarser grasses, they are not generally used on golf turf.

# Sources of Phosphorus

Sources of phosphorus are limited. The chief organic form is bone meal, although with the exception of blood, all other organics contain varying amounts of phosphoric acid. While the phosphorus of bone is insoluble, solution takes place in the soil. Steamed bone is more readily available than raw bone and contains somewhat more phosphorus.

Superphosphates are the most important commercial source of phosphorus. Materials containing from 16 to 45 per cent phosphoric acid are on the market. They are produced by treating raw phosphate rock with sulphuric acid to convert the insoluble phosphoric acid into soluble compounds.

Superphosphates seldom burn turf badly. They have but little effect in soil reaction. When applied to the soil they are converted into insoluble calcium or iron phosphate, depending upon soil reaction, but resolution takes place.

The various ammonium phosphates comprise a third class. Materials containing 20 and 45-48 per cent phosphoric acid, with 11-16 and 20 per cent nitrogen are available. They are water soluble and are apt to burn the turf. Their tendency is to increase soil acidity. These materials are admirable sources of phosphoric acid where some quick acting nitrogen is also needed.

Muriate of potash is the outstanding source of potassium. The imported material contains 48-50 per cent potash, whereas the American product, produced in California, contains 60-62 per cent. Potash fertilizers are water soluble, hence apt to burn. When used on acid soils the initial tendency is to increase soluble acidity. The potash is taken up by the silt and clay so leaching loss is negligible.

In any program of fertilization inherent differences between fairways and greens must be recognized. Besides higher state of maintenance, clippings are removed from greens, so this accentuates loss of phosphorous and potassium. There is also a fundamental difference between established fairways and new fairway seedings.

On established fairways the same nutrient requirements govern improvement of thin turf as are required to maintain good grass. The difference is simply one of amount of fertilizer needed and frequency of application. More generous applications at more frequent intervals is important where grass is thin.

The principles underlying a fairway program are comparatively simple. It should be built around nitrogen feeding, with phosphoric acid and potash playing minor roles.

Nitrogen, besides encouraging turf to spread and form dense sod, is the element responsible for clover control. Generous nitrogen is essential on poor fairways; on good turf rates can be reduced so as to barely satisfy the need for this element. Actual rates depend upon the kind of nitrogen material selected. With water soluble fertilizers individual applications should not exceed several hundred pounds per acre of pure nitrogen fertilizer

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JACOBSEN POWER GREEN MOWERS or 500 to 600 pounds of mixed fertilizer to avoid burning. With organics much higher rates are permissible. When the two are used in combination 100 to 200 pounds soluble nitrogen fertilizer can be safely used with organics at 700 to 1,500 pounds per acre.

Need for phosphorus can be judged by using one of the soil phosphorus test kits now on the market, provided lead arsenate has not been used. In most cases phosphate applications need not be repeated short of 2 to 4 year periods.

Amount of available soil phosphorus, texture of soil and kind of grass determine rate of phosphate applications. By the Truog method sandy soils containing 50 pounds or more and heavy soils containing more than 75 pounds available phosphorus per acre rarely need additional phosphate. Less phosphate is needed on the sandy soils than on heavy soils to produce equal results. Bents and fescue require less phosphate than Kentucky bluegrass.

On very acid soils where lime is needed, it is best to lime several months in advance of phosphate applications for this tends to increase phosphate efficiency.

Potash may be ignored with the possible exception of fairways on sands, mucks and peats. On these soils 100 to 200 pounds per acre of 50 per cent potash every two to four years should suffice.

Where complete fertilizers are preferred those high in nitrogen with moderate phosphoric acid and potash content should be selected.

# When to Fertilize

Spring and fall are the logical seasons for fairway fertilization, especially if rainfall is the sole source of moisture. Besides being the seasons of greatest rainfall, air temperatures are most favorable for growth. Spring applications should be made before active growth begins, and fall fertilization should be in early September if results are desired before winter. If soluble materials are included, applications should not be made during hot weather. Burning may occur even though the grass is dry.

Obviously care should be taken to insure uniform distribution. This is obtained by using one of the modern two-wheel hopper type distributors. Operators should be cautioned to overlap, and when the machine is stopped on fairways the outlet spouts should be closed to avoid burning from localized fertilizer.