# *The A B C of Turf Culture*

## Principles Underlying the Practical Use of Fertilizers on Greens and Fairways

By O. J. NOER

BECAUSE of variations in soils, amount of rainfall and climate it is impossible to devise set rules which can be universally applied, yet certain fundamental principles underlying the use of fertilizers on turf grasses have wide application, and if these are thoroughly understood practices best adapted to local conditions are easily set forth. Phosphoric acid, for instance is very important on new seedings to encourage rapid root development and thus insure a uniform turf.

Some materials encourage the growth of fine textured grasses and discourage clover and weeds, while others unduly stimulate clover. Unless the fertilizer contains plant food elements which reinforce soil deficiencies failure attends their use. Thus, if turf needs only nitrogen it is useless to aply other than nitrogenous fertilizers. The more slowly available materials supply plant food over considerable periods and are particularly adapted to use on sandy soils where the danger of plant food loss from leaching is great.

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Editor's Note: For the past four years Mr. Noer has investigated the value of various fertilizers in relation to golf turf at the Soils Department, University of Wisconsin, under a fellowship established by the City of Milwaukee.

The rate of fertilizer application depends upon the amount of essential plant food contained in the material and its availability. Water soluble nitrogen fertilizers are best applied in small amounts at frequent intervals to avoid burning and loss from leaching, and provide a more uniform supply of plant food. Organic nitrogen fertilizers can be applied in larger amounts because soil processes gradually convert the insoluble nitrogen into soluble and available forms. Thin turf usually is an indication impoverished soil and requires generous fertilization to stimulate spread of existing turf. All factors must be considered when fertilizer programs are being instituted.

### *Fertilization of Established Greens*

Greens are in especial need of fertilization. Frequent watering induces heavy growth and increases the losses of plant food from leaching. Large amounts of plant food are constantly removed in the clippings taken off the greens. Mr. Burkhardt at Westwood Country Club, Cleveland, reports an average of 35 pounds of dry clippings removed daily from each green. This is equivalent to 3500 pounds in 100 days. If the clippings contained 2 per cent nitrogen (heavily fertilized turf frequently contains even more) 70 pounds of nitrogen were removed, equivalent to 350 pounds sulphate of ammonia. The large amount of nitrogen removed from greens during a season is rarely appreciated.

Nitrogen is the most essential plant food element, and fortunately need for nitrogen is most easily recognized. It is responsible for active vegetative growth and dark green color. Occasionally only the tip ends of the stolons on vegetative greens are dark green and the main stems are devoid of color. Here the need is so acute that the plant moves nitrogen from the older portion of the stems to the growing tips.

In order to maintain uniform growth the turf must obtain a uniform and continuous supply of nitrogen. It is not feasible to build up large reserves of nitrogen in the soil because of the danger of loss from leaching and denitrification. This danger exists even with insoluble organic nitrogen, because it is converted into soluble forms by bacteria in the soil, and if the amount is larger than the turf roots can take up and utilize, loss occurs.

Too much nitrogen tends to produce coarse broad leaves, and a weak succulent turf, particularly if readily available nitrogen is used. Such turf is probably more susceptible to such diseases as brown-patch.

All things considered best results are obtained from moderate applications at frequent intervals rather than occasional heavy applications.

Where good top dressing containing well rotted manure is used very little response is obtained from additional applications of phosphoric acid and potash. Both tend to encourage clover so their use should be based on trials which demonstrate the need for larger amounts than are contained in top dressing mixtures.

All carefully conducted tests indicate that sulphate of ammonia encourages the growth of the finer textured grasses, and discourages clover, and nitrate of soda has the opposite effect. Consequently sulphate of ammonia should be chosen as the source of quickly available nitrogen, and used to produce these effects. Ammo-

phos is an excellent material where additional phosphoric acid is required.

There is also a need for more slowly available nitrogen, to insure a uniform supply. In the past this was supplied by the manure used in compost piles. Near large cities manure is difficult to obtain and many clubs are substituting such materials as cottonseed meal, poultry manure and Milorganite. None of these require long composting and should be mixed with the top dressing just previous to top dressing the green, or they can be spread broadcast over the green and top dressing mixture applied over them.

The amount and character of turf growth must be used as a guide in determining the amount of nitrogenous fertilizer to apply. Because of the danger of burning, sulphate of ammonia applications should not exceed three to five pounds per 1000 square feet in the spring and fall, and one to three pounds in the hot summer months. The organic materials can be applied at rates of 15 to 30 pounds per 1000 square feet. The heavier rates are safe during cool weather and the lighter amounts during the hot summer months. Naturally heavier applications should be made where the turf is poor. Trials on the particular course should be used as a basis for determining the rate and frequency of fertilizer applications.

There are a number of methods of applying fertilizer which give good results. No matter what the method the importance of uniform distribution cannot be too strongly emphasized. Fertilizers do not move laterally in the soil, all movement being vertical. Uneven applications result in uneven growth and unsightly greens.

Sulphate of ammonia is sometimes applied dry, in solution, or mixed with top dressing. The method selected depends upon individual preferences. When applied dry uniform distribution is difficult to obtain, because of the small amount of material used. Some greenkeepers use the small hand type seeder and apparently secure uniform distribution. Thorough watering immediately following the application is essential to avoid serious burning of the turf. When applied in solution the barrel cart sprinkler is most widely used. The sulphate of ammonia solution runs out of the small perforated holes in the horizontal pipe attached to the barrel, but unless the holes are closely spaced uniform distribution is not obtained. In a few instances the sulphate is fed directly into the watering line by means of a proportioner such as devised by Charles Erickson of the Minekahda Club at Minneapolis. The sulphate is quickly applied and the large volume of water eliminates the danger of burning. Frequently the sulphate is applied mixed with the top dressing. This method reduces the danger of burning because the ammonia is taken up and held temporarily by the clay and humus. Care must be exercised to secure uniform distribution of the sulphate in the mixture. Preliminary mixing with sand or soil to obtain more bulk facilitates mixing.

Sometimes, on newly built greens, fertilizers do not produce marked results. This is usually due to poor soil texture. Sand or humus was not worked into the heavy soil, root systems do not develop in the hard surface soil and suffer for want of needed oxygen. Until this is corrected good turf cannot be expected.

### *Fertilization of New Greens*

Good greens can be obtained without the use of manure provided surface soil of a sandy loam texture is available. Proper soil texture is important, because it is not easily modified after turf is established. Much larger amounts of sand are required to modify the texture of heavy soil than if humus materials are used. Medium to coarse sands are preferable to fine grained sands.

The fertilizer needs of seeded greens are slightly different from those planted with stolons, due to differences in amounts of stored food. The small grass seed contains very little reserve food, whereas the stolon is capable of establishing itself with little outside assistance. Hence seeded greens must receive sufficient phosphoric acid and nitrogen before seeding to insure rapid growth of the young seedling turf plants, and phosphoric acid plays a most important part because of its stimulating effect on root development. Stolon planted greens can be fed from the top in the top dressing mixtures which are applied at frequent intervals.

Phosphoric acid is best applied in quickly available forms such as acid phosphate. From 5 to 10 pounds per 1000 square feet is sufficient. Applications should precede seeding so the fertilizer can be worked into the shallow surface layer of soil. This is important because later surface applications of phosphate do not move down into the soil rapidly. Nitrogen on the other hand moves freely in the soil so surface applications even after seeding are effective. If sulphate of ammonia is used as the source of nitrogen heavy applications must be avoided because of the danger of killing the sensitive young seedling. Usually not more than 5 to 10 pounds per 1000 square feet should be used, and is best worked into the soil a few days before seeding or planting. If organic nitrogen fertilizers are used larger amounts can be safely applied, and should be worked into the soil so soil processes can release the nitrogen.

### *Fertilization of Established Fairways*

There appears to be an ever increasing appreciation of the value of fairway fertilization. In the past attempts were made to improve poor turf with seed alone. If the soil supplies only enough plant food to support the scattering turf plants, how can the new struggling seedlings establish themselves? Had conditions been favorable for growth the existing plants would gradually spread and fill in the bare spots. Where the stand of turf is poor and the soil is not too hard some seeding, in addi-

tion to fertilizer, may be advisable. In the future, however, more emphasis will be placed upon fertilization than re-seeding.

If the turf is thin fertilizer is almost surely needed, and unless steps are taken to obtain dense turf weeds will become prevalent. Moss so commonly considered an indication of sour soil is more correctly an indication of impoverished soil. Profuse clover growth may be due to a lack of nitrogen. The nodules on the clover roots contain bacteria capable of drawing upon the inexhaustible supply of atmospheric nitrogen and converting it into forms the clover can utilize. Thus the clover thrives while the turf grasses languish for want of nitrogen.

Based on the relative amounts of plant food removed by the turf a fertilizer high in nitrogen and potash would seem best for fairways. But most soils contain at least fifteen times more potash than nitrogen and it is only the sandy soils, which are low in potash, that are apt to need additional potash. A fertilizer relatively high in nitrogen, moderate to low in phosphoric acid and with little or no potash ordinarily gives best results.

In the past manure was extensively used on fairways, but the present tendency is to substitute other materials partly as a result of increased demand for the limited supply, and a more intelligent use of other materials. With manure there is always danger of introducing obnoxious weeds, play is interfered with late in the fall and early spring until the refuse is removed. The supposed advantages of added humus are overestimated because it is impossible to incorporate the manure with the soil.

A ten ton application of manure is considered light, yet at least 80 pounds nitrogen and 50 pounds phosphoric acid are applied to each acre. Failure to obtain satisfactory results with substituted materials are often due to the insignificant amounts of plant food applied. Thus 500 pounds bone meal add only about 12 pounds nitrogen to the soil. Until reasonable applications are made disappointments will continue. Naturally the amount of fertilizer to apply must depend upon the condition of the turf and soil, and the material used. If the turf is poor and thin the soil is usually poor also, and more fertilizer must be applied to encourage heavier growth. A thousand to fifteen hundred pounds per acre of the better organic materials is not unreasonable under such conditions. If it is simply a case of maintenance smaller applications suffice.

When sulphate of ammonia or Ammo-phos are used applications should be light and at frequent intervals. The reasons for this have been stated elsewhere.

Fertilizers are best applied in the early spring or fall or just before winter sets in. Mid-summer applications are rarely effective, due to extended periods of dry weather. When applied in the early fall marked benefits are frequently obtained before winter sets in. Late fall applications should be confined to organic materials and only where there is no danger of bad surface washes.

### *Fertilization of New Fairway Seedings*

The main advantages accruing from fertilization of new fairway seedings result from a quicker growth and production of dense uniform turf. With fall seedings it is possible to obtain a heavy turf before growth ceases and such turf is better able to withstand severe winter weather. Ordinarily nitrogen and phosphoric acid are most important, but some potash may also be needed on sands. The cost of fertilizing an 18-hole course should not exceed $2000 to $3000, and is a small item of expense. Once obtained it is difficult and expensive to improve poor turf.

The first few weeks following seeding are most critical. The small grass seed contains only enough plant food to initiate growth and when growth commences the young seedling must obtain food at once. Its ability to forage for food is curtailed by a limited root system. Unless the soil is abundantly supplied with plant food many weak seedlings succumb and a thin turf results. This is the reason why even supposedly fertile soils so often respond to fertilizer applications prior to seeding.

Phosphoric acid benefits new seedings mainly by stimulating rapid root development, thus enabling the weaker plants to compete with the strong seedlings. This insures a uniform turf. Nitrogen hastens top growth which is also preliminary to extensive root development.

Acid phosphate is a better source of phosphoric acid than bone meal, being more quickly available. When added to the soil the phosphoric acid is precipitated as finely divided insoluble phosphate. The extreme fine state of division permits rapid solution when the plant makes heavy demands. The acid phosphate is best applied prior to seeding and worked into the surface soil with a disc. Surface applications after seeding are not so effective because the phosphoric acid is precipitated at the surface and is slow to work down into the zone where root development takes place.

Nitrogen can be supplied from a number of different materials. If organic sources are used heavy applications can be made at the time of seeding with little danger of burning the seedling or loss from leaching. With the soluble materials lighter applications should be made at the time of seeding to guard against injury to the seedling and danger of loss by leaching. Later applications should be made as needed.

When mixed fertilizers are used mixtures high in nitrogen, medium to high phosphoric acid and low potash content should be selected. Ten tons of manure per acre is usually considered a very moderate application. At least 80-90 pounds nitrogen and 40 to 50 pounds phosphoric acid are added to each acre. Unless these amounts of plant food are approximated disappointment

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is almost certain to attend the use of substituted materials, although somewhat less nitrogen is frequently effective because of the greater availability of the nitrogen in other materials.

In order to obtain uniform distribution, so essential to success a good fertilizer distributor should be used. Either the two-wheel lime and fertilizer spreader or the end-gate type lime spreader is effective. With the former type machine phosphate and nitrogenous materials can be mixed right in the hopper. The necessity of uniform applications is not generally appreciated. Fertilizers should be applied prior to the last discing so they can be worked into the soil.



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