Soil Tests That Tell Needs of Golf Turf

By O. J. NOER

SOIL testing to determine fertilizer needs has become extremely popular. Most state agricultural experiment stations have soil testing laboratories where thousands of soil samples are tested each year for a nominal charge. These laboratories specialize in farm crops, but accept samples from golf courses within the state.

The interpretation of results and recommendations are best in the states where the experiment station staff includes a specialist in turf grass management.

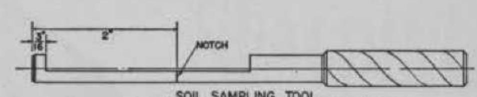
Some county agricultural agents have facilities for making quick soil tests. The work is done free or for a very modest fee. Many fertilizer manufacturers have a soil testing service for their customers and seldom make a charge. Some of them employ trained agronomists who are qualified to interpret results — others do not. There are inexpensive soil test kits on the market for the layman. The better ones for testing soil reaction are eminently satisfactory, provided instructions are followed. Several of the kits for quick soil tests are satisfactory, but some are not trustworthy. The best way is to send samples to a responsible laboratory manned by trained personnel where reagents are kept fresh, and are tested for accuracy. Results should be interpreted by a competent turf grass agronomist.

A soil deficiency in one or more plant nutrients is blamed whenever grass behaves badly. Usually this is true, because a fertile soil is essential for growth. But other factors may contribute to poor growth. They must become favorable before fertilizer will produce the results expected of it. These factors include:

1. Use of grass suited to climate and local weather.
2. Sufficient light, or use of shade-tolerant grasses.
3. Favorable air temperatures, both daytime and at night.
4. An adequate supply of moisture.
5. Sound maintenance practices.
6. Protection from injury—mechanical, insects, and disease.
7. A good soil environment—50 per cent solids, 25 per cent air, 25 per cent water.
8. Favorable soil reaction.
9. A fertile soil containing needed nutrients in ample amounts.

Seven Factors to Explore

In times of stress the proper procedure is to explore the top seven factors first. Then by correcting the unfavorable ones environmental conditions will be made satisfactory for growth. After doing that, ap-



SOIL SAMPLING TOOL
MADE FROM DISCARDED STEEL GOLF CLUB SHAFT

This simple, practical soil sampler is made on an emery wheel from a golf shaft with a heavy sidewall. Those of light stock break easily.

The cutting edge is only 3/16 in. to facilitate removal of plugs, and is sharpened. The slot is ground just below center so plugs slip out easily and the mark for measuring plugs is EXACTLY 2 INCHES.

ply lime or the kind of fertilizer indicated as being needed by the soil test. Lime and fertilizer never do the job expected of them until all the factors governing grass growth are favorable.

Soil testing is even more useful when used to take stock of soil reaction and to provide an inventory of the mineral soil nutrient elements, principally phosphorus, potassium, calcium, and magnesium. Existing nitrogen tests are not satisfactory for grassland areas. Need for it can be judged by the behavior of the grass. Poor color, slow rate of growth, thin turf, and the presence of clover and weeds are the best and surest guides in determining need for this growth-promoting element. In semiarid regions tests should include the determination of soluble salts. With the above information it is easier to devise a sensible fertilizer program.

A colorometric test is a good way to determine soil reaction and possible need for lime. The test expresses soil reaction in terms of pH (potential or hydrogen). The scale is 0 to 14, with 7 as the dividing or neutral point. Figures below 7 repre-

Table I — Limestone Application to Fairways

SOIL pH The Yardstick Used To Express Acidity	Degree of Acidity	Bluegrasses, Rye, Bermuda Sandy Loam	Loams & Clay	Fescues & Bentgrasses Sandy Loam	Loams & Clay
7	Neutral	0	0	0	0
6.3 to 7.0	Very Slight	0	0	0	0
5.8 to 6.2	Slight	1000	1500	0	0
5.3 to 5.7	Medium	2000	3000	1000	1500
4.8 to 5.2	Strong	3000	4000	2000	3000
4.0 to 4.7	Very Strong	4000	6000	3000	4000

sent increasing acidity, and higher figures increasing alkalinity. Each figure differs by a multiple of 10, so pH 6 is 10 times, pH 5 is 100 times, and pH 4 is 1,000 times more acid than neutral.

Soils fall within the range of pH 4.0 to pH 8.5, but more commonly within the narrower limit of pH 5.0 to pH 7.5. Most turf grasses grow best in the range of pH 6.0 to 7.5. Soils which are more than moderately acid, that is, below pH 5.7, definitely need lime. Its use is justified without regard to any other factor.

Soil Reaction

All plants are affected by the reaction of the medium in which they grow. The direct effect upon rate and amount of growth is the major reaction. Another is related to the soil tilth. Reaction influences the accumulation of organic matter, the animal and micro-organisms of the soil, and the availability of the soil nutrient elements.

Kentucky bluegrass is a classic example of a lime-loving turf plant. It will not tolerate marked acidity and it is at its best when reaction is above pH 6.0. Ryegrass is another lime-lover. The bentgrasses and fescue can withstand considerable more acidity, but respond to the use of lime on moderate to strongly acid soil. Among the Southern grasses, Bermuda grows best when soil is not more than slightly acid. Carpetgrass can tolerate more acidity. Centipede is an acid-loving plant like azaleas, etc. Lime induces severe iron chlorosis with resultant loss of grass.

Rates For Applying Lime

The rate for applying lime is influenced by the kind of soil, also. Less lime is needed on a sandy soil than on a loam or clay soil to produce the same change in pH.

Kind of grass and type of soil are taken into account in Table I (above) of suggested rates for applying finely ground limestone to fairways.

The figures below are for golf greens. The indicated rates are for finely ground limestone:

Soil Reaction (pH)	Rate per 1,000 Sq. Ft.
6.6 to 7.0	0
6.1 to 6.5	0-10 pounds
5.6 to 6.0	10-20 pounds
5.1 to 5.5	20-40 pounds
4.6 to 5.0	40-60 pounds
4.0 to 4.5	60-80 pounds

Hydrated lime should not be applied at more than 10 to 20 pounds per 1,000 sq. ft. at any one time. The heavier rate is safe only when grass is dormant.

In hot weather even 5 pounds may scorch the grass. Hydrate must not be used immediately before or right after an application of fertilizer containing chemical nitrogen in the ammonia form.

When lime is needed a test for calcium and magnesium should be made. If calcium is very low, heavier liming than would otherwise seem necessary is justified. A reasonable amount of calcium is desirable to prevent fluctuations in reaction and because of its beneficial effect upon soil granulation.

The test for magnesium is more important. Some soils are so low in magnesium that turfgrass growth is depressed as a consequence. By applying a dolomitic limestone acidity is corrected and magnesium is provided besides. The dolomite should contain 20 to 30 per cent magnesium reported as the oxide.

Marked acidity has an adverse effect upon the physical condition of loams and heavier soils. The minute and clay particles exist alone as individual entities. This dispersed condition is referred to as deflocculated soil. Surfaces become compact and impervious to water penetration. Root systems are shallow.

Calcium-saturated clay particles associate

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themselves into groups or granules which act like larger particles. This flocculated condition has a marked favorable effect upon the internal structure of clay soils. Water infiltration is improved and deeper rooted turf is the rule.

Soil reaction influences the availability of soil nutrients. The solubility or availability of phosphorus decreases as the soil becomes more acid. According to Truog, the best point for the availability of phosphorus is in the range of pH 6.2 to 6.5. Strong acidity increases the solubility of trace elements such as copper, manganese, iron, etc. Copper and manganese toxicity can result. Conversely, over-liming may make the trace elements and iron insoluble and hence unavailable. Lime-induced iron chlorosis in semi-arid regions where soils are usually highly alkaline in reaction is a classic example.

Grass roots absorb nourishment from the soil solution in the form of soluble salts. The quantity of dissolved nutrient salts in the soil water is small, seldom more than enough for a day or two. The solution must be replenished quickly, especially when growth is rapid. A fertile soil is one capable of keeping the soil solution well supplied with nutrient elements at all times. A productive soil is never static. It is dynamic, undergoing constant change throughout the growing season as a result of the solvent action of the carbonic acid generated by roots, and activity of micro-organisms.

There are three kinds of nutrients—based on solubility—in every soil. They are the water soluble, the easily soluble, and the difficultly soluble substances. The soluble nutrients in the soil solution are immediately available, the easily soluble are readily available, and the difficultly soluble ones are unavailable in the foreseeable future. It is similar to a person's finances. The pocket change is enough for a day or two. It is immediately available. The bank deposit can be drawn upon when the pocket change becomes exhausted. It is readily available. Defaulted stocks and bonds are of no immediate value, but may yield something eventually. They correspond to the difficultly soluble soil nutrients.

Some quick tests determine the soluble or immediately available soil nutrients only. They may be useful in greenhouses, etc., but not for grassland areas. Others determine the soluble and the readily soluble nutrients in varying degree. Some of these are the best for golf course soils.

As stated before, soil tests for nitrogen are not reliable for turfgrass areas. Existing methods measure the quantity of soluble nitrate nitrogen in the soil. Grass roots absorb this type of nitrogen quickly, as soon as it is formed by soil micro-organisms. The grass may be doing as well as can be expected and the test may show nitrogen to be deficient. So turf behavior is best for judging need for nitrogen.

Testing for only four of the 15 essential plant nutrient elements may seem inadequate to some people. Years of testing has shown that they provide enough basic information upon which to build an effective fertilizer program.

The commonly used tests, such as Purdue, Truog, Morgan, Spurway, LaMotte, or Edwards, etc., differ essentially in the strength of the solvent used to extract the soil nutrients. A small amount of soil is extracted for a definite period of time. The best solution dissolves the soluble and relatively soluble soil nutrients. Some solutions are too weak to solubilize the reservoir of relatively soluble substances which are insoluble in water yet become available quickly. Results obtained with these weak solvents are misleading. They fail to show any difference between soils of high and low levels of phosphorus and potash.

Samples were collected from fairways at Pickwick and Evanston golf clubs in the Chicago district. They were tested by three methods: Truog, Purdue and Spurway. Results are shown in Table II.

Table II

		Truog*	Purdue	Spurway
Pickwick	A	10	Very Low	Low
	B	10	Very Low	Very Low
	C	25	Very Low	Low
Evanston	A	90	High	None
	B	90	High	None
	C	100	High	None

**Fairway soils should contain 75 to 100 lbs. per acre, or more*

There was marked response to the use of phosphate at Pickwick but no response at Evanston. The Truog and Purdue methods were in accord with field practice. This was not true of the Spurway method.

Similar results were obtained with potassium tests. The Truog and Purdue methods were in accord with field practice. The Spurway method was not.

These results show the necessity for using a good method, one which distinguishes between a soil of low and one of high potassium content.

For simplicity and convenience, most laboratories report results as very high, high, medium, low, or very low. Although these terms appeal to the layman, they can be misleading. The fertilizer level in greens should be higher than fairways because clippings are removed and growth is maintained at a higher level.

By reporting amounts as pounds per acre, it is possible to establish one level for greens and another for fairways. For example, with the Truog method fairways should contain a minimum of 75 to 100 lbs. phosphorus and 175 to 200 lbs. potassium. The corresponding levels for greens should be 200 to 300 lbs. phosphorus and 300 to 400 lbs. potassium per acre.

The tests are no better than the samples submitted to the laboratory. Improper sampling is responsible for erratic results and is another cause for questioning the value of soil testing.

Depth of sampling is very important. The amounts of phosphorus and potassium decrease sharply with depth on grassland areas because the soil is not disturbed after turf coverage is obtained. Failure to realize this fact has been responsible for misleading results even with the better soil testing methods.

Three samples were taken at the same spot on one of the check strips on fairway fertilizer plots at Blue Mound CC, Milwaukee, Wis. The Truog method was used with the following results:

Depth of Soil	Lbs. Phosphorus Per Acre
1½ inches	65
3 inches	35
4 inches	25

Phosphorus is reasonably good in the 1½ in. plugs. It would be considered very low in the other two. Yet the response to applied superphosphate was insignificant.

Trips To The Top

A cable car complete with ball washer (right front railing) flattens out a steep hill at Jackson Municipal GC, Seattle, Wash. for footsore golfers. Among the first to test the new lift were (l to r): Kermit Rosen, city park board; Pat Lesser, National and Western Women's amateur champion; Dick Masterson, city amateur champ; and Dr. Phil Smith, also of the city park board.

To obtain consistent results and to show and follow trends, it is necessary to take samples to *exactly the same depth at all times.* A sampling depth of exactly 2 in. has proven very satisfactory. All plugs should be uniform in diameter from top to bottom. A good sampling tool can be made from a discarded steel golf shaft as illustrated in the accompanying diagram.

The samples should be representative, composite samples. Each composite should consist of six to ten cores. The cores should be left intact in the bag. This will permit the laboratory to spot matting, presence of sand or peat layer, etc.

Variations in soil, topography, and turf determine the number of composite samples to collect from fairways. On level areas of uniform soil from four to six taken from widely separated fairways should do.

When sampling a localized area of poor turf, be sure to collect another sample from a nearby spot of good grass.

In the letter of transmittal be sure to include information about drainage, kind of grass, watering and fertilizing.

Each composite sample should be placed in a clean, new container. Small manila paper bags, obtainable at a nearby grocery store, are excellent. Label the outside of each sample plainly with a *soft lead pencil.*

Yearly testing is seldom necessary. A test every two to four years is usually enough.