# *Soil Testing for Turfgrasses*

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SOIL TESTING is the primary tool in determining soil fertility status and nutrient requirements of turfgrass. In Pennsylvania alone, 7,083 soil samples from turfgrass areas were analyzed in 1976 and 1977. Despite the general emphasis placed on the use of soil testing for determining phosphorus, potassium, and lime requirements, little research has been done directly relating soil testing to turfgrass areas. Each phase of the turfgrass soil testing program — sampling, laboratory analysis, the correlation and calibration of soil test results — should be thoroughly investigated if meaningful fertilizer recommendations are to be made.

Research presently being conducted at several universities should provide some of the needed information regarding turfgrass soil testing. At Penn State, soil test research for turfgrass areas is being supported by grants from the O. J. Noer Research Foundation and The Pennsylvania Turfgrass Council. Recently completed efforts regarding turfgrass soil testing consisted of a study of soil sampling procedures and a survey of seven turfgrass soil testing laboratories to determine differences that currently existed in procedures and recommendations.

Obtaining a representative soil sample is essential if reliable fertilizer recommendations are to be made. Nevertheless, sampling has generally been recognized as the largest source of error in testing programs. Recommended soil sampling procedures for maintenance fertilization require samples two to four inches in depth, with any thatch material being discarded. Studies were therefore initiated to understand the effects of both sampling depth and thatch on soil test results.

Soil samples were taken from turfgrass areas with known fertility histories in 1.5- or 2.0-inch increments to a depth of six inches. Soil samples were also taken from these areas both with the thatch material and without it. All soil fertility values were affected by sampling depth in at least one of the areas sampled. The magnitude of change and whether values increased or decreased with depth appeared to be dependent on the past management, with factors such as fertilization, irrigation, top-dressing, and level of soil modification having some influence.

Generally, nutrient levels tended to decrease with depth when the area had received maintenance applications of the respective nutrients, while pH tended to increase with depth **(Table 1)**. These results were attributed to higher organic matter levels near the soil surface and to the slow downward movement through the soil of surface-applied nutrients.

On bentgrass plots that had received different rates of phosphorus fertilization, however, soil phosphorus levels increased by 14 pounds per acre from the 0- to 2-inch to the 2- to 4-inch range where no phosphorus was applied. At the same time, values were lower by 65 pounds per acre in the 2- to 4-inch layer where 9.2 lb $P_2O_5$/1000 ft$^2$ was surface-applied annually. Apparently nutrient removal by the turf was greatest in the surface two inches, resulting in a depletion of phosphorus near the surface when none was applied. When phosphorus was applied, it accumulated near the surface. This result indicates that a two- or three-inch sample is probably more representative than a deeper sample.

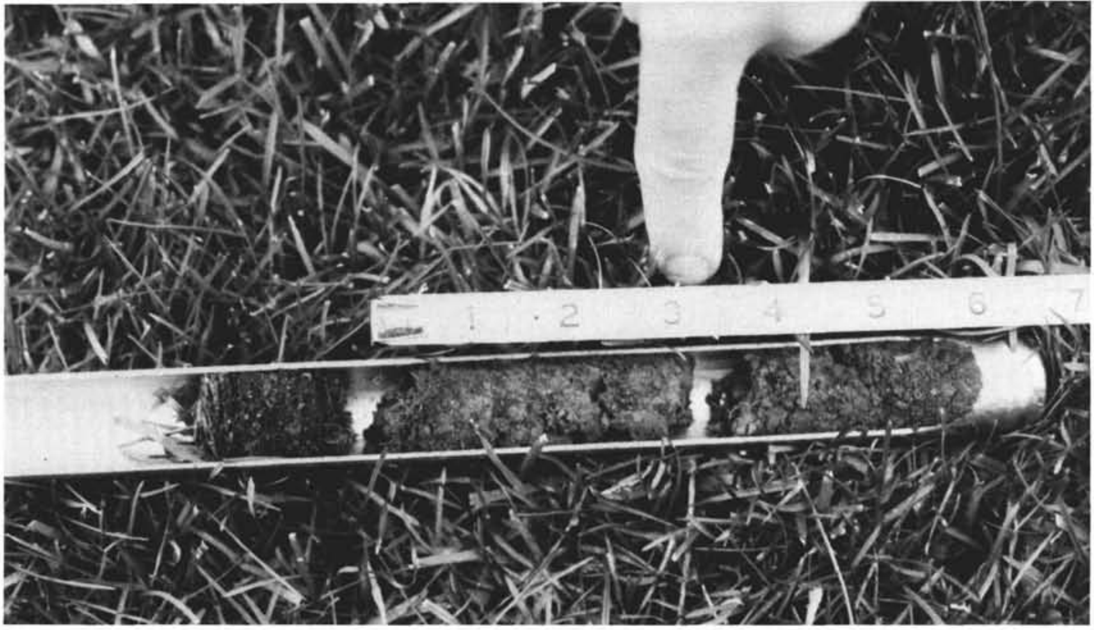
These relatively large changes in soil test values with sampling depth would indicate that sampling to an exact depth would be critical for obtaining reliable fertilizer recommendations. However, because of the wide range of soil test values associated with each prescribed rate of nutrient application, fertilizer recommendations were not greatly affected by sampling depth. Therefore, contrary to past warnings in the soil sampling procedure, small variations of from half an inch to one inch from the recommended sampling depth do not appear to be of great importance.

**TABLE 1**

**The effect of sampling depth on the soil test results of an area receiving phosphorus and potassium applications.**

| | Soil Test Results | | | | | |
|---|---|---|---|---|---|---|
| **Depth** | **pH** | **P** | **K** | **Mg** | **Ca** | **CEC*** |
| *inches* | | lb/A | meq/100 g | | | |
| 0-2 | 6.7 | 143 | 0.49 | 1.9 | 7.4 | 11.7 |
| 2-4 | 6.8 | 117 | 0.31 | 1.2 | 7.7 | 10.9 |
| 4-6 | 6.9 | 91 | 0.29 | 0.9 | 7.8 | 10.4 |

*CEC — cation exchange capacity



*Thatch and sampling depth affect soil test results. Most labs recommend thatch removal and a sampling depth of 3 inches for established turf.*

Although it is generally recommended that the thatch material be discarded from the soil sample, roots are present in the thatch layer and surface-applied nutrients must move through this layer before reaching the soil. Therefore, soil samples which contain the thatch layer may be more representative of an area than samples from which thatch is removed. Results from several test areas in this study showed that nutrient levels, especially potassium, were higher in samples which contained thatch, whereas the pH was generally lower **(Table 2)**. Potassium fertilizer recommendations were lowered by as much as 3.0 lb $K_2O$/1000 ft$^2$ and limestone recommendations increased by as much as 50 lb/1000 ft$^2$ when thatch was included with the soil sample. It is apparent from these results that present recommendations regarding the handling of thatch when sampling the soil should be carefully followed; however, further studies need to be conducted on the availability and use of nutrients in the thatch layer and whether the inclusion of thatch with the soil sample would result in a more representative sample. Studies are presently being initiated that will hopefully answer some of these questions.

The survey of turfgrass soil testing laboratories, which consisted of sending soil samples and a questionnaire concerning different aspects of turfgrass soil testing, showed that many differences existed among laboratories in procedures and recommendations. Although these differences occurred in several areas, the most important were found in the interpretation of soil test results and the resultant fertilizer recommendations. Each of the laboratories received subsamples of seven soil samples. They were requested to analyze each sample and report the test results and recommendations for the maintenance fertilization of a Merion Kentucky bluegrass tee.

Recommendations among the laboratories for a given soil varied by as much as 5 lb $P_2O_5$/1000 ft$^2$, 6 lb $K_2O$/1000 ft$^2$, and 180 lb limestone/1000 ft$^2$. Recommendations for two of the soil samples are shown in **Table 3**. Although laboratories using the same chemical extractants usually reported similar soil test results, fertilizer recommendations still were often considerably different.

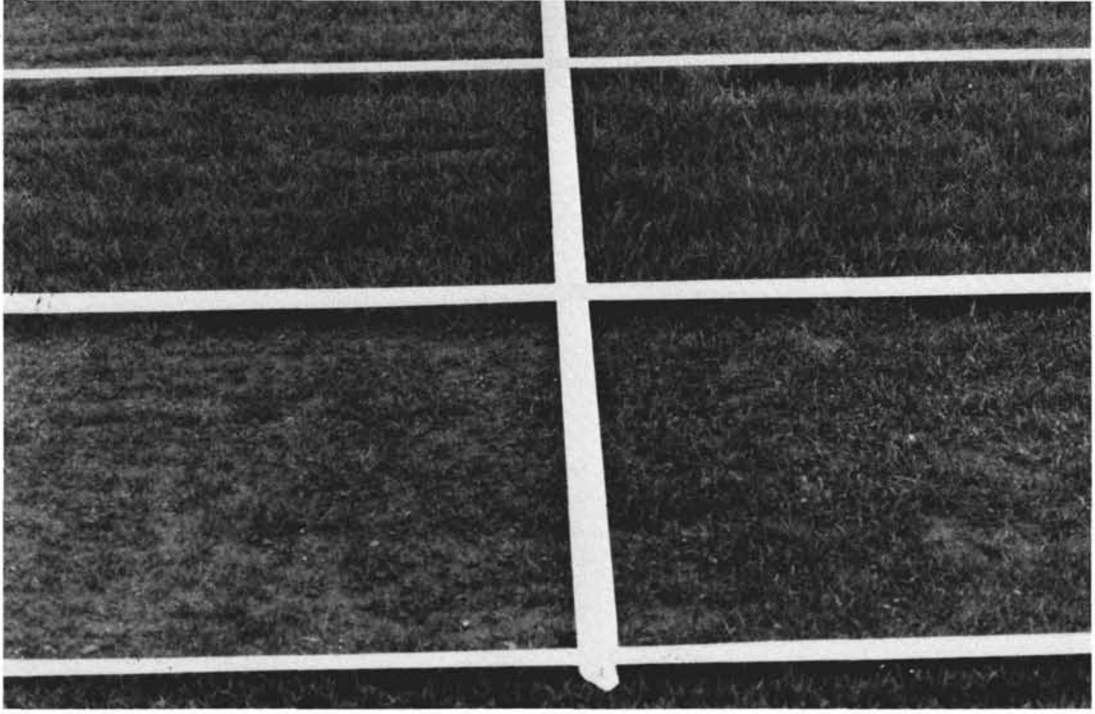
Several factors, including differences in soils and climate in the region of the individual laboratories, may have contributed to the wide range of recommendations for a given soil sample. The primary reason for the differences, however, probably can be attributed to the lack of turfgrass soil testing research upon which recommenda-

**TABLE 2**

## The effect of thatch on soil test results.

| Type of soil sample | Soil Test Results | | | | | |
|---|---|---|---|---|---|---|
| | pH | P | K | Mg | Ca | CEC* |
| | | lb/A | meq/100 g | | | |
| with thatch | 6.7 | 125 | 0.20 | 2.1 | 7.9 | 12.2 |
| without thatch | 6.8 | 118 | 0.11 | 2.0 | 7.8 | 11.4 |

*CEC — cation exchange capacity



*Turfgrass responses, such as seedling vigor, are useful in soil test calibration studies. Phosphorus application (right) increased seedling vigor and density of Kentucky bluegrass (bottom), perennial ryegrass (middle), and chewings fescue (top).*

tions must be based. These wide differences in recommendations point to a critical need for turfgrass soil test calibration data, i.e., relating turfgrass response to the application of different rates of nutrients on soils with different initial fertility.

Unfortunately, most turfgrass fertility research in the past has not been designed to be of direct value to soil testing. Thus, one of the major efforts at Penn State in turfgrass fertility research will be to provide some of the much-needed information regarding turfgrass soil test calibration. Ten field calibration tests, including those for both establishment and maintenance fertilization, were started in 1977, with several more to begin early in 1978. Factors such as turfgrass quality, growth, disease incidence, recovery from injury, and rate of establishment will be used to evaluate fertility treatments. Because of the differences that exist in soil and climatic conditions among and even within the major regions of the country, various states need to initiate turfgrass soil test calibration studies if significant improvements are to be made in existing soil test programs.

In a day where efficient use of fertilizer is required from both economic and environmental standpoints, these types of studies are of increasing importance. Hopefully, with the completion of new and current studies, turfgrass soil testing programs will have a more sound basis upon which to interpret soil test results, with the end product being more meaningful and reliable fertilizer recommendations.

**TABLE 3**

**Phosphorus, potassium, and lime recommendations by different laboratories for the maintenance of a 'Merion' Kentucky bluegrass tee.**

| Laboratory | Fertilizer Recommendations | | | | | |
|---|---|---|---|---|---|---|
| | Soil #1 | | | Soil #2 | | |
| | $P_2O_5$ | $K_2O$ | Lime | $P_2O_5$ | $K_2O$ | Lime |
| | lb/1000 ft$^2$ | | | lb/1000 ft$^2$ | | |
| #1 | 5.5 | 4.0 | 50 | 5.5 | 3.0 | 125 |
| 2 | 3.0 | 2.0 | 0 | 2.1 | 2.0 | 0 |
| 3 | 5.1 | 4.0 | 100 | 4.1 | 7.0 | 100 |
| 4 | 2.1 | 3.0 | 0 | 2.1 | 3.0 | 80 |
| 5 | 2.5 | 2.4 | 30 | 2.3 | 2.4 | 165 |
| 6 | 0.9 | 1.0 | 35 | 0.9 | 1.0 | 70 |
| 7 | 6.0 | 1.5 | 40 | 2.5 | 1.5 | 80 |