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Soil Test Recommendations Handbook For Agronomic Crops

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This handbook provides information on the interpretation of soil test reports for agronomic crops from Penn State's Agricultural Analytical Services Laboratory. The Penn State soil test report (see enclosed example) is divided into four parts: (1) SOIL TEST REPORT FOR: (2) SOIL NUTRIENT LEVELS, (3) RECOMMENDATIONS and (4) ADDITIONAL RESULTS. These sections are discussed in detail below and are followed by recommendation tables for each of the individual crops.

SOIL TEST REPORT FOR: Sample information

The top of the report provides information on both the laboratory identification of the sample (DATE, LAB NO., and SERIAL NO.) and the identification of the sample (COUNTY, ACRES, FIELD, and SOIL). Consistency in identifying fields (FIELD) simplifies comparison of soil tests on the same fields over time to determine and react to any trends.

Laboratory identification is also important if the grower has a problem with the results or a question about the report. Should laboratory personnel need to retrieve the soil sample or report to check a problem or answer a question, they will need to know the LAB NO. of the report. Prompt action is required as the soil samples are not retained indefinitely.

Summaries of soil test results may be used in educational programs. However, individual results will not be released outside of Penn State without permission of the client.

SOIL NUTRIENT LEVELS: Interpreting the results

Soil nutrient levels are given as parts per million (ppm) elemental P, K, and Mg. As a rule of thumb to convert ppm to lb/A multiply ppm x 2. The elemental results can be converted to oxide forms using the following conversions: $P \times 2.3 = P_2O_5$, $K \times 1.2 = K_2O$, $Mg \times 1.6 = MgO$

The results of the laboratory analysis are meaningless by themselves; they must be interpreted by relating the lab values to known crop response under local conditions. The interpretation, based on crop response research, is given as a bar chart that indicates whether the level for each nutrient is below optimum, optimum, or above optimum for the crop to be grown. The definition for each category is given below. The optimum range for each crop is given on each crop recommendation table in this manual.

Below Optimum soil test level indicates that the nutrient is probably deficient and that the deficiency will likely limit crop growth. There is a high probability of a profitable return from correcting a low level. The greatest economic return per dollar invested in fertility is usually achieved through medium application rates to low-testing soils. However, the maximum profit per acre and the lowest cost per unit of crop produced is achieved as the nutrient application rate is increased to the recommended level. The recommendation for a low-testing soil is designed to gradually build up the nutrient level to optimum and to maintain it at that level.

Optimum soil test level indicates that the nutrient is probably adequate and will likely not limit crop growth in a typical growing season. There is a low probability of a profitable return from increasing the soil test level above optimum. The recommendation for an optimum-testing soil is designed to offset crop removal in order to maintain the nutrient in the optimum range. If you are soil testing on an annual basis, no maintenance fertilizer is needed when the soil tests in the optimum range.

Above Optimum soil test level indicates that the nutrient is more than adequate and will not limit crop growth. There is a very low probability of a profitable return from applying a nutrient to a soil testing above optimum. Consequently, no fertilizer is recommended on these soils. Too much of a plant nutrient may cause a nutrient imbalance in the soil and, as a result, in the plant. Additional broadcast applications of fertilizers or manures to soils that are very high not only result in unsatisfactory economic returns, but they can also adversely affect plant growth and environmental quality.

RECOMMENDATIONS

The recommendations on the soil test report are made for a three-year sequence of crops. These recommendations are made based on the soil test results and on the information you provided such as crop to be grown, expected yield, crop rotation and plow depth.

Limestone recommendation (See Table 1)

Limestone is applied to neutralize the acidity in the soil and thus raise the soil pH to the optimum range for crop growth. The limestone recommendation is based on the amount of exchangeable acidity measured in the soil and the optimum soil pH level for the crop. Use table 1 in this manual to make limestone recommendations. The recommended limestone application is a one time application to cover the three years on the test. For most agronomic crops the optimum pH is 6.5. For alfalfa and barley the pH goal is 7.0. pH requirements vary from crop to crop. However, because only one limestone recommendation is made for three years the recommendation on the report will adjust the pH for the most sensitive crop to be grown during the three years. The actual pH goal used to make the limestone recommendation is indicated next to the recommendation on the report.

The limestone recommendation is based on a liming material that is 100% calcium carbonate equivalent (CCE) in neutralizing power and based on liming an acre furrow slice approximately 7 inches deep. If a liming material is used that is not near to 100% CCE (90–110% CCE), the rate should be adjusted for lime quality. ST-2 "Liming Materials Conversion Table" gives the details for making this simple but important adjustment. If the limestone is going to be mixed with a larger

volume of soil by deeper tillage, the recommendation is increased to account for this. Any adjustment for tillage depth is indicated on the report.

See PSU Agronomy Facts #3 “Soil Acidity and Liming” for details on Limestone recommendations, liming material quality and liming practices.

Magnesium (Mg) recommendation (See Table 2)

If the soil magnesium level is below the optimum level for crop production, magnesium will be recommended to raise the level to optimum. Use table 2 in this manual to make Mg recommendations. Agricultural limestone is generally the most economical and convenient source of magnesium for agronomic crops. In addition to the actual amount of magnesium recommended (lb Mg/A), the magnesium recommendation is also given as the minimum percentage of Mg in the recommended amount of limestone required to meet the magnesium needs. Mg requirements vary from crop to crop. However, because the Mg recommendation is linked to the limestone recommendation, only one Mg recommendation is made. This recommendation is based on the needs of the most sensitive crop to be grown during the three years.

Low Mg levels in soils may result in low Mg levels in forage crops especially if a significant amount of N and/or K fertilizer is applied. This can result in potentially fatal grass tetany in animals. Use caution if grazing in this situation. Apply the recommended Mg; however, be aware that if the K is very high and the Mg is low it may not be possible to correct this soil imbalance immediately. Therefore, it is critical that your feed rations are properly balanced based on the actual forage mineral content.

Nitrogen (N) recommendation (See Crop Recommendation Tables)

No soil analysis is used to make the N recommendations on the report. These recommendations are based on estimates of crop requirements for N as determined by extensive crop response research under Pennsylvania conditions. Most recommendations are based on the information you provided about the crop to be grown and the expected yield. The recommendations are given as pounds of N required per acre for each crop. The crop tables contain the N recommendations for each crop.

Legumes are able to fix the N they need from the atmosphere and thus do not require additional N. Also, growing a legume in a rotation preceding a N-requiring crop may result in a high level of residual N in the soil that can be utilized by the following crop. The N recommendations must be adjusted to take into account this residual N. Recommended credits for this residual N are provided with the N recommendation. Adjust the N recommendation accordingly. Adjustments for legumes are given in the applicable crop recommendation tables in this manual.

Nitrogen supplied by manure should also be considered in determining the N management for a crop. Residual N from past manure applications may reduce the amount of N required for the current crop. Then the N in manure applied for the current crop must be accounted for. Manure N availability varies depending on how it is handled and applied. Manure analysis is available from the Agricultural Analytical Services Lab at Penn State. See the Manure Management section of the Penn State Agronomy Guide for details on manure management.

Nitrogen testing is not possible as part of a routine soil testing program. N is very dynamic in the soil plant system. Consequently the available N changes throughout the season. For N testing to be valid it must be conducted very near to the time when the crop has the most demand for N. A N soil test, the Pre-sidedress Soil Nitrate Test (PSNT) has been developed for corn. This test is an in-season pre-sidedress analysis for nitrate-N in the surface foot of soil. The test is very good for determining if the soil contains adequate N to produce the current corn crop, and it can give some guidance for adjusting sidedress N recommendations. This test is especially useful where manure is expected to contribute significantly to the N needs of the crop. This test is available only for corn. (See PSU Agronomy Facts #17 “Pre-sidedress Soil Nitrate Test for Corn” for details.) A new test utilizing a chlorophyll meter to estimate the N status of the corn based on the color of the corn leaves has been developed. This test is also a pre-sidedress test, run at the critical time just before the major N demand by the crop. However with this test the chlorophyll level in the corn leaves is measured directly with a hand-held meter. Thus no samples need to be collected and analyzed and the results are available immediately. The recommended use and accuracy of this test is similar to the PSNT. (See PSU Agronomy Facts #53 “The Early-Season Chlorophyll Meter Test for Corn” for more details.)

Phosphorus (P) and Potassium (K) Recommendations (See Crop Recommendation Tables)

The P and K recommendations are based on building below optimum testing soils up into the optimum range. Once an optimum level has been established the recommendation is to maintain that level by applying P and K to offset the amount that is removed by the harvested crop. The optimum ranges for agronomic crops are 30-50 ppm P and 100-150 ppm K for grain crops and 150-200 ppm for forage crops. Once the soil level is above optimum no P or K is recommended. Each crop recommendation table contains the optimum P and K levels for that crop and the P and K recommendations. To determine a P or K recommendation look in the left hand column of the table for that crop and find the soil test level from the chart in the middle of the soil test report. Go across the table to the column that corresponds to the expected yield for the crop. This will be the P or K recommendation given as lb/A of P₂O₅ or K₂O, respectively.

Very high soil test levels should be avoided as much as possible. High soil nutrient levels not only represent an economic loss but they may also indicate potential crop, animal or environmental problems. Very high P levels in the soil may lead to crop production or feed quality problems and may result in potentially harmful P loss to the environment. Best management practices may be necessary to reduce the potential for environmental problems with P. Very high K levels in the soil can lead

to nutrient imbalances in forage crops that can cause serious health problems in animals. Use caution when grazing forage crops especially if the soil magnesium is not also in the high range. It may not be possible to correct these soil imbalances in the short term. Feed rations must be balanced accordingly. Very high soil test levels are often a side effect of utilizing manure to supply the N needs of crops. Usually when manure is applied to meet the N requirements of a crop excess P and K will be applied. Over time this can lead to very high P and K levels in the soil. This should be monitored with regular soil testing and appropriate management action should be taken to limit applications in excess of crop needs or to minimize potential negative crop, animal or environmental consequences.

Recommendation Messages (See Crop Recommendation Tables)

The messages and comments that accompany the recommendations are an important part of the report. Immediately under the amounts of nutrients needed on the report are several messages specific for the actual results and recommendations. These messages, for each crop, can be found on the crop recommendation tables in this manual. "Standard Messages" are messages that always appear for that crop. Other messages listed with the P and K recommendations in the tables are printed depending on the situation. The conditions for when the messages are printed are also included with each table. Important general comments about the results and recommendations are found on the back of the report. These comments and the material enclosed with the report are all part of the recommendation.

ADDITIONAL RESULTS

Test levels for calcium (Ca) and exchangeable acidity; and optional tests for organic matter, nitrate nitrogen and soluble salts are provided in this section. Also included here are calculated values for the soil cation exchange capacity (CEC) and percent saturation of the CEC by K, Mg, and Ca. These calculated values are not used in making recommendations they are provided for reference only.

Analysis

The soil testing procedures currently used by the Penn State soil testing program are listed on the report. This information is useful if you compare analytical results from different labs. Direct comparisons can be made only between labs using *exactly* the same procedures. There are many different methods in use around the country, each with strong and weak points. Which test will be used in a given area is based on research to determine how well the test works under local conditions. The tests used by the Agricultural Analytical Services Lab at Penn State have been determined to work best for Pennsylvania conditions.

Keeping records

Keeping good records of soil test results can be very helpful for fine-tuning fertility management. To make the most of the result, samples should be collected regularly and very consistently (e.g., same time of year, same depth). Once optimum soil test levels are attained, the goal is to maintain those levels. A decrease or increase in soil test level at a relatively constant yield might indicate under-fertilization or over-fertilization, respectively. Nutrient applications should be adjusted according to the observed trends. Soil test levels will vary from one test to the next; but if an unusual value is observed, the soil testing lab can recheck the results and/or you can submit a new sample for confirmation.

As with all Penn State Cooperative Extension programs, your feedback and suggestions for improvement of the soil testing program are always welcome.

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