



The Penn State soil test report is divided into four parts:

### **SOIL TEST REPORT FOR: Sample information**

The top of the report provides information on the laboratory identification of the sample. Check identification information to be sure that it is correct for the samples you submitted. Consistently identifying fields simplifies comparison of soil tests on the same fields over time to determine and react to trends.

If you suspect a problem with your soil analysis, contact the Agricultural Analytical Services Laboratory at (814) 863-0841 and provide them with the LAB NO. on the report. Your sample will be retested at no extra charge if requested. Prompt action is required, however, because 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. Password-protected access to your soil test report and soil test data is also available through the laboratory web site (<http://www.aasl.psu.edu>). Contact the laboratory for additional information and to obtain a password.

### **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 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.

**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 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. Typical nutrient recommendations and guidelines for changing them for a different crop and/or yield level are given in ST-2 "Fertilizer Recommendation Table". Complete recommendation tables are also available on the lab web site: <http://www.aasl.psu.edu>

#### **Limestone recommendation**

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. The recommended limestone application is a one time application for the three years on the report. For most agronomic crops the optimum pH is 6.5. For alfalfa and barley the pH goal is 7.0. 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 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**

If the soil magnesium level is below the optimum level for crop production, magnesium will be recommended to raise the level to optimum. 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

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 crop response research under PA 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.

Growing a legume in a rotation preceding an 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 using the credits indicated on the report to take into account this residual N.

Nitrogen supplied by manure should also be considered. 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.

Nitrogen testing is not possible as part of a routine soil testing program. N is very dynamic in the soil/plant system and 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. Two in-season N tests, the Pre-sidedress Soil Nitrate Test (PSNT) and the Chlorophyll Meter Test are available to help with N management in corn. These tests are especially useful where manure is expected to contribute significantly to the N needs of the crop and can help guide sidedress N applications if necessary. See PSU Agronomy Facts #17 "Pre-sidedress Soil Nitrate Test for Corn" or PSU Agronomy Facts #53 "The Early-Season Chlorophyll Meter Test for Corn" for details.

### Phosphorus (P) and Potassium (K) Recommendations

Recommendations are given as pounds of  $P_2O_5$  and  $K_2O$  required per acre for each crop. 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.

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 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 which 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

An important part of the report is the messages and comments that accompany the recommendations. Immediately under the amounts of nutrients needed are several messages specific for the actual results and recommendations. 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.

Zinc (Zn), copper (Cu), and sulfur (S) results are also given. Deficiencies of these nutrients are rare in Pennsylvania. Consequently, reliable interpretations and recommendations only on the basis of soil test can not be made, although results can be compared to ranges normally observed in PA soils (see Table below). Soil test levels below the normal range may indicate a possible deficiency, but do not guarantee a response to additions of these nutrients. Plant tissue analysis should be used to determine if the plants are deficient and to help guide fertilizer applications.

Normal ranges of Zn, Cu and S in Pennsylvania Soils (Mehlich 3 soil test)		
Zn (ppm)	Cu (ppm)	S (ppm)
1-80	0.5-15	10-75

Zinc deficiency is most likely on soils with below-normal Zn levels, high pH, a sandy texture or where soil P is high from fertilizer additions. If both soil and plant zinc levels are below normal and especially if any of the above conditions exist, the recommendation is to broadcast and incorporate 8 to 10 lb/A Zn once every 5 years or apply 2 lb Zn/A in the starter. Copper deficiency has not been observed in Pennsylvania.

Sulfur deficiency is rare in Pennsylvania because of the significant amount of S that is deposited in our rainfall. As the acid rain problem is reduced, S may become more limiting in the future. If both soil and plant S levels are below normal, it is recommended that part of the fertilizer N requirement of the crop be met with ammonium sulfate. A rate to supply 10 to 20 lb of S/A should be adequate for most crops in this situation. There is a higher likelihood of a sulfur deficiency on soils with below normal S levels that are also very low in organic matter and/or sandy-textured.

Copper and Zinc can accumulate in soil to levels that are toxic to plants. Toxicity to agronomic crops has not been observed in Pennsylvania even on soils testing 2 – 3 times the normal range, but has occurred in soils contaminated by industrial activity. Plant tissue analysis should be conducted on soils with more than 2 times the normal range to determine if levels are above normal. If both soils and crop tissues are above the normal range steps should be taken to prevent further addition of these elements to the soil. Certain agricultural practices, such as use of copper or zinc sulfate hoof baths, can add these elements to soil.

#### **OTHER INFORMATION**

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, collect samples 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 levels at a relatively constant yield might indicate underfertilization or overfertilization, 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 for the soil testing program are always welcome.

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