MSU Soil and Plant Nutrient Laboratory

Frequently Asked Questions | Sampling Instructions | Price List | Soil Test Report

The following information is being provided for farmers. For consumer soil test report information, please see the MSU Extension Soil Web pages for Consumers.

A farmer who is knowledgeable about the changing fertility status of the soil in each field can invest wisely in fertilizer and lime to produce the most economical crop yields. A soil test provides the needed information about soil pH, lime need and available nutrient levels. This bulletin will aid farmers and all agribusiness personnel in understanding the soil test results and fertilizer recommendations provided by the Michigan State University Soil Testing Laboratory.

A. Background Information

Sample: the farmer's identification number or code

Tray: the laboratory identification for each sample. Give this number to the lab when inquiries are made regarding test results or fertilizer recommendations

Acres: the number of acres represented by the soil sample

Soil Management Group: the texture of the soil sample as determined by the lab. There are three classification: organic (peat or muck) soils, mineral fine texture including clay, loam, clay loam, and sandy clay loam soils, and mineral course texture including sandy loam, loamy sand, and sandy soils.

Plow Depth: the depth (inches) to which limestone will be incorporated if lime is needed. Listing the wrong depth could result in too much or too little lime being recommended. If information on "plow depth" is not given, 9 inches is used to determine the lime requirement. When lime is spread and incorporated with a moldboard plow, the depth indicated should be the depth of plowing. When the soil will not be moldboard plowed within two years of the lime application and the lime will be incorporated with a disk, chisel plow or similar equipment, indicate "plow depth" as only one half of the implement's working depth in the field. That's because such tillage tools effectively incorporate surface broadcast materials to only one half the depth of tillage.

For no-till systems, list two inches as the "plow depth" since limestone is not incorporated and will not appreciably alter the soil pH at depths greater than two inches. Where continuous no-till is being used for crop production, a second soil sample should be taken to a two inch depth for determining pH changes near the surface and the appropriate lime need.

Previous Crop: the last crop which was grown in the field. When alfalfa or clover is the previous crop, a nitrogen credit is given. The nitrogen credit equals [40+(.60 times percent stand)] where over 5 to 6 plants/square foot in an established field is considered to be a 100 percent stand. If percent stand is not indicated, 70 percent is assumed and a nitrogen credit of 80 lb/acre [e.g. 40+(.6 x 70) is given. The nitrogen credit is reflected in the printed nitrogen recommendation.

1st Crop: 2nd Crop: the next two crops to be grown (in sequence) or two crop options which may be grown. Fertilizer and lime recommendations are given for each crop, but apply lime only once.

Yield Goal: the yield which the grower seeks to attain on the field. Yield goal is best based on a five year yield average, not a highest one year yield. When figuring the yield average over several years, do not include unusually high or low yields. If a yield is not indicated by the farmer, the computer will select an average yield for that soil management group.

Manure: Answer "yes" or "no" to indicate whether or not manure has been, or will be, applied to this field. When "yes" is indicated and the manure has already been applied, adjustments will be made in the recommendations according to the amount of nutrients applied in the manure. If the manure has not yet been applied, recommendations will be made in a footnote as to the amount of manure needed to supply the nutrient requirements for the crop to be grown. The actual credits depend on the type, form and rate of manure being applied. If no information is provided about manure application, a "no" will be printed.

B. Soil Test Results

Soil pH: the level of active soil acidity or alkalinity. Above 7.0 is alkaline, 7.0 is neutral and below 7.0 is acid. This measurement, sometimes referred to as the water pH, is made with soil in distilled water. A pH between 6.0 and 6.5 is best for production of most field crops. Alfafalfa, however, grows best at pH 6.6 - 7.2.

Lime Index: an indicator of the reserve or potential acidity in soil and is used to determine the quantity of lime needed to correct the pH of an acid soil. Lime index mearsurements are made only on samples testing less than pH 6.8. The lime index usually falls between 70 and 60. With a lime index above 70, no additional lime is needed. As the lime index decreases below 70, more lime is required to bring the pH back up to 6.5.

Soils with greater reserve acidity have a higher capacity to resisit change in pH. Therefore, clay soils which have high levels of reserve acidity require more lime to bring about a 1.0 pH unit change than do sandy soils which have lower levels of reserve acidity. Hence, a clay loam soils and a sandy loam soil with the same soil pH will have different "lime indexes" and lime needs. For more information on liming, see Extension Bulletins E-471, Lime for Michigan Soils, and E-1566, Facts About Lime.

Soil test values are reported in parts per million. For mineral soils, 1 ppm (parts per million) equals 2 lb/acre. The soil test values are indicators of the relative available nutrient levels in the soil. The soil test values for phosphorus, potassium, calcium and magnesium are not equal to the total amounts of these nutrients available in the soil for plant uptake, but they are correlated with plant growth and yield responses, and with fertilizer needs. As the soil test values increase, the need for supplemental fertilizer nutrients decrease.

Phosphorus: (P) levels of less than 10ppm are very low, 20 -30 ppm are medium and above 50 ppm are very high for most field crops. Vegetables require higher levels of available P so that a soil test of 50 - 75 ppm is desired.

Potassium: (K) test of less than 30 ppm are very low for most field crops, 80 to 105 ppm are medium and above 150 ppm are very high. For vegetables, a potassium test level of 140 to 150 ppm is desired.

Calcium: (Ca) levels are generally adequate in Michigan soils. Even acid soils needing lime generally contain sufficient calcium for plant growth. This test value is used primarily to calculate nutrient balances and in making magnesium recommendations.

Magnesium: (Mg) levels are considered inadequate for most crops when any of the following conditions exist:

1. Soil test values are less than 40 ppm in mineral soils or 175 ppm in organic soils.
2. Magnesium accounts for less than 3 percent of the total bases (calcium + magnesium + potassium expressed in milliequivalents).
3. Relative to the total bases content (percent bases), the magnesium percentage is less than the potassium percentage.

Zinc, Manganese and Copper: analyses are made only on special request. These micronutrients are reported in parts per million. Adequate levels of zinc and manganese vary with the crop and soil pH. Deficiency of manganese is most likely to occur above pH 6.5. Deficiency of zinc is most likely above pH 7.0. For most crops, a manganese level of 20 ppm is sufficient and less than 10 ppm is inadequate. A zinc level of 10 ppm is sufficient and less than 2 ppm is inadequate. Sufficiency in between these levels depends on the crop and the soil pH. As soil pH increases, higher manganese and zinc soil test levels are required in order to provide sufficient amounts for optimum plant growth. Copper levels are adequate (above 0.5 ppm) in most Michigan mineral soils. Copper deficiencies are most likely on newly developed organic soils. For detailed information on interpretation of the micronutrient test levels, see Extension Bulletin E-486, Secondary and Micronutrients for Vegetable and Field Crops.

Organic Matter: is determined only on request and reported as percent of active organic matter in the soil. The active rather than the total organic matter content is reported because this is the part which is important in nutrient holding and the adsorption of herbicides. Most mineral soils in Michigan have active organic matter contents between 1 and 4 percent.

Cation Exchange Capacity (CEC): an indicator of the nutrient holding capability of a soil. It is a relatively permanent characteristic of each soil and is not easily changed. In general, the greater the clay and organic matter contents, the higher the CEC of a soil. CEC is calculated by adding together the amount of soil test values of potassium, calcium, magnesium, and hydrogen held on the soil particles. It is expressed in milliequivalents per 100 grams of soil. Loamy sands and sands usually have a CEC less than 8. The CEC of sandy loams frequently falls between 8 and 12. Loams, clay loams and clays usually have a CEC greater than 12. As the soil pH changes, the CEC value will also vary somewhat. The higher the CEC, the greater the capacity of the soil to hold nutrients and bind certain pesticides. The CEC of a soil is also important in determining permissible heavy metal loading rates associated with land application of sewage sludge.

Percent Bases: information on the nutrient balance among potassium, calcium and magnesium. The percentages reported assume K, Ca and Mg comprise 100 percent of the exchangeable bases, and are used to determine potential magnesium deficient situations. Mg should be above 3 percent and greater than the percentage of K. For example, 6.8 percent K and 4.2 percent Mg indicates a Mg-deficient soil situation.

Fertility Index: relative status of each nutrient. It is a function of the soil test level, crop to be gown and yield goal. Table 1 illustrates how the phosphorus fertility index changes as these three variables change. A fertility index of 0-33 is low, 34-66, medium and 67-100, high. The fertility index shown on the soil test report is for the first crop only.

Whenever the fertility index for P or K is very high no fertilizer is recommended for that nutrient. A recommendation for the secondary and micronutrients is given only when the fertility index is less than 50. The ferility index is directly related to the percent of the yield goal a farmer can expect to achieve from the amount of a given nutrient in the soil (soil test value) without any addition of fertilizer. This percent yield goal is referred to as "relative yield."

Table 2 shows the relationship between fertility index (FI) and relative (RY). As long as the yield otentials of fields are similar, investing in phosphorus or potassium will be most beneficial where the FI is low, and less beneficial where the FI is high. Additional nutrients applied to a soil with a low FI

will produce a greater yield reponse than the same application to a field with a high FI. Therefore, the FI can be used to decide how fertilizer investments can best be spent to maximize whole farm income.

Table 1. Fertility index (FI) changes with the crop, soil test and yield goal.

Soil Test	Crop	Yield Goal	Fertility Index	Fertility Rating
lb P/A		bu/A	%	
30	Corn	100	51	M
50	Corn	100	85	H
70	Corn	100	120	VH
70	Corn	150	76	H
70	Corn	200	56	M
70	Wheat	60	77	H
70	Wheat	80	66	M
70	Soybean	40	116	VH
70	Soybean	60	87	H

Table 2: Relationship between fertility index (FI) and relative yield (RY).

Fertility Rating	Fertility Index	Relative Yield
	%	%
Low	0-33	0-78
Medium	34-66	79-94
High	67-100	95-100

C. Fertilizer Recommendations

Fertilizer recommendations printed on the right side of the report form are based on the soil test results and crop information provided. Recommendations are given in pounds of N (nitrogen), P_2O_5 (phosphate) and K_2O (potash) for the major nutrients and in pounds of element per acre for each of the micronutrients. Commercial fertilizer analyses are similarly reported as percent of the element present. When the cropping information is provided, fertilizer recommendations are given for two crops. These may be for a two crop sequence or two alternative crops.

Major Nutrients: Recommendations given for N, P_2O_5 and K_2O are those which will result in the most economical yields. This assumes that the soil sample is representative, that a realistic yield goal has been chosen that average weather prevails and that good management practices are used. However, due to variations in these factors, the most economical fertilizer rate may vary from those given.

The nutrients recommended can be supplied from a wide variety of fertilizer materials and applied through various combinations of pre-plant broadcast, planting time band and sidedress applications. Since many ways are available for a farmer to supply the nutrients in the recommendation, it is suggested that the farmer work closely with the local Cooperative Extension Service agricultural, a

consulting agronomist, or horticulturist, and/or a fertilizer dealer to determine the most suitable fertilization program for her/his farming operation.

Micronutrients: The micronutrients for which recommendations are most frequently given are zinc (Zn), manganese (Mn), copper (Cu) and boron (B). Recommendations for Zn, Mn, and Cu are based on crop response, soil pH and soil test level. No recommendation will be given for these three micronutrients without a soil test. Boron is recommended based on crop response, soil texture and soil pH. Fertilizers are labeled according to the percent of a micronutrient contained. The percentage needed to supply the recommended amount will depend on the fertilizer rate being applied. For example, if a standard planting time fertilizer is applied at 100 ppm, it will need to contain 2% Mn to supply 2 ppm. If the fertilizer is applied at 200 ppm, a 1% Mn content is adequate to supply 2 ppm of Mn.

Secondary Nutrients: Magnesium (Mg) is the only secondary nutrient for which a recommendation is given on the routine report. The need for Mg is indicated by one of two footnotes: 1) "Magnesium tests low, use dolomitic limestone," or 2) "Magnesium tests low, broadcast 25-50 ppm Mg or row apply 5-10 ppm Mg" The first footnote is printed when lime is required to neutralize excess soil acidity. The second footnote is printed when the magnesium test is low and the soil pH is adequate so that no lime is needed.

Lime: When lime is required to neutralize excess soil acidity, the lime recommendation includes two pieces of information. The first line gives the pH to which the soil should be increased by liming. This is dependent on the crop(s) being grown. When alfalfa is part of the crop rotation, pH 6.8 is indicated. For most other field and vegetable crops, pH 6.5 is indicated. The next line indicates the tons of lime required to achieve this pH. The lime recommendation will be printed only once unless crops 1 and 2 have a different lime requirement. When this occurs, the following footnote will print out: "Lime to suggested pH for the most important crop in your rotation. Only one application of lime is intended." Do not apply both rates. The rate of pH change varies with lime fineness and the degree of incorporation. When thoroughly incorporated to the depth indicated, The soil pH goal will be achieved in two to three years with agricultural lime. For no-till situations, the lime recommendation is designed to neutralize the acidity in the top two inches.

D. Footnotes

The numbers printed on the footnote line refer to the numbered footnotes listed in the footnote section. The footnotes listed for crop 1 and crop 2 may differ and apply only for that crop recommendation. The footnotes are printed out in special situations to help the farmer better understand the recommendations and maximize crop production through proper fertilizer management.

Both your county agricultural agent and fertilizer dealer are in a good position to help you interpret your recommendation sheet. Use their services.

MICHIGAN STATE UNIVERSITY

MICHIGAN STATE UNIVERSITY
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(517) 355-0218

SOIL TEST REPORT FOR:	ADDITIONAL COPY TO:
STEVE WAGNER ABC, INC 1871 YOSEMITE OKEMOS MI 48864	

DATE	LAB	COUNTY	Previous Crop	ACRES	FIELD ID	SOIL
5/17/2004	16113	Ingham	Corn silage		Jp120g	Mineral

SOIL NUTRIENT LEVELS			Below Optimum	Optimum	Above Optimum
[1]Soil pH 7.2	Lime Index				
[2]Phosphorus (P)	54	ppm			
[3]Potassium (K)	115	ppm			
[3]Magnesium (Mg)	380	ppm			

ADDITIONAL RESULTS — **Optional Tests**

Calcium (Ca) (ppm)	CEC (meq/100 g)	% of Exchangeable Bases K	Mg	Ca	Micronutrients (ppm) B	Cu	Mn	Zn	Fe	Organic Matter %	Nitrate-N ppm
2777	17.3	1.7	18.3	80.0			32.5	5.6			

RECOMMENDATIONS

Limestone: NONE

Target pH = 6.5

Tillage Depth:

% Stand:

Plant Nutrients:

Year	Crop	Expected Yield	Nitrogen (lb N/A)	Phosphate (lb P_2O_5/A)	Potassium (lb K_2O/A)	Micronutrient: (Optional) Boron (lb B/A)	Manganese (lb Mn/A)	Zinc (lb Zn/A)	Copper (lb Cu/A)
1	Sorghum-Sudangrass haylage	20 ton	60	0	350	0.0	0.0	0.9	

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AGI-Business/ Wagner (ABC) Please e-mail to Jennifer Otto

Test Method: 1-1:1 soil:water pH, 2-Bray P1 Extractant, 3-1N Ammonium Acetate Extractant