University of Missouri Extension

G9111, Reviewed October 1, 1993

Editor's note: Use the XPLOR order form to purchase the printed version of this publication, which includes a sample soil test report.

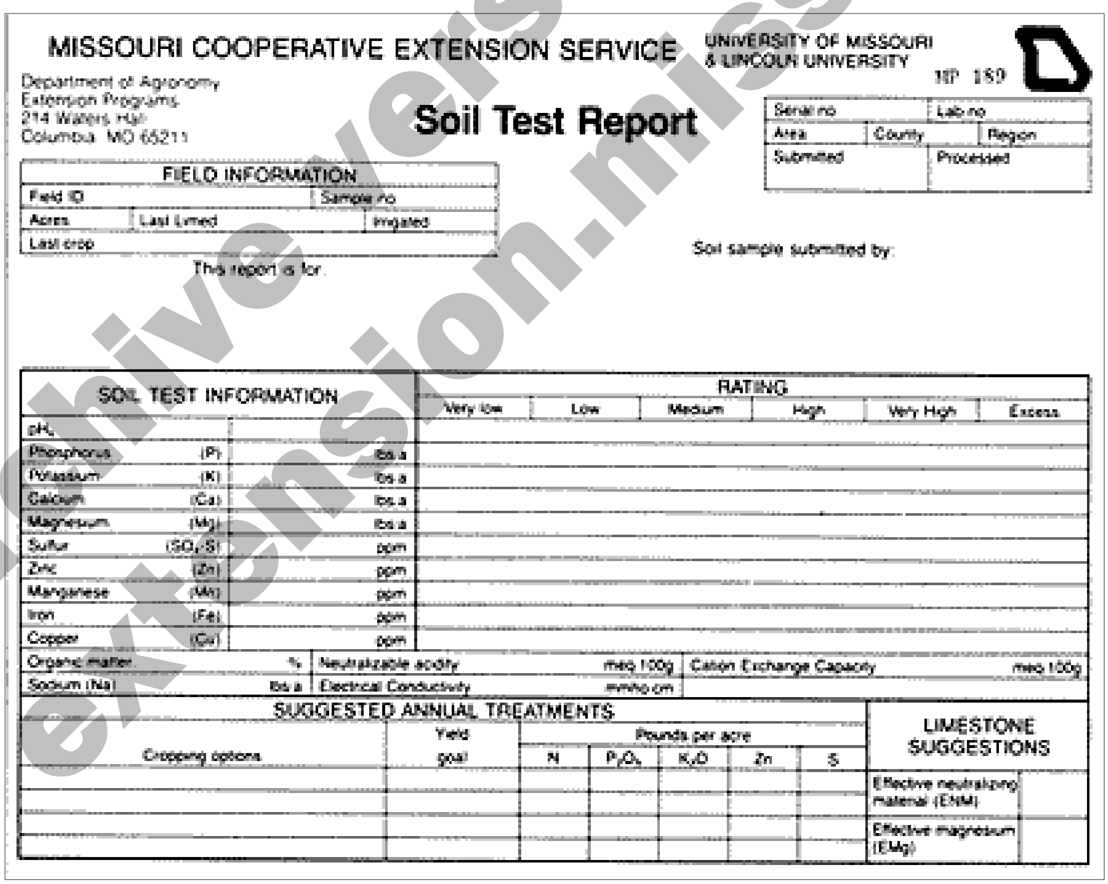
Using Your Soil Test Results

Daryl D. Buchholz, J.R. Brown and Roger G. Hanson Department of Agronomy, University of Missouri-Columbia

To use your soil test report to the best advantage, you need to understand the information it provides. With the proper soil test interpretations and suggested fertilizer treatments, you will have a fertilizer program for maximum profitable crop production.

The soil test report provides information on:

- Soil test results and ratings.
- Suggested fertilizer and limestone treatments.
- Fertility management practices or concerns (see the sample form).



MISSOURI COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF MISSOURI & LINCOLN UNIVERSITY
MP 189

Department of Agronomy
Extension Programs
214 Waters Hall
Columbia, MO 65211

Soil Test Report

Serial no | Lab no
Area | County | Region
Submitted | Processed

FIELD INFORMATION
Field ID | Sample no
Acres | Last limed | Irrigated
Last crop

This report is for:

Soil sample submitted by:

SOIL TEST INFORMATION			RATING: Very low	Low	Medium	High	Very High	Excess
pH$_s$								
Phosphorus (P)		lbs a						
Potassium (K)		lbs a						
Calcium (Ca)		lbs a						
Magnesium (Mg)		lbs a						
Sulfur (SO_4-S)		ppm						
Zinc (Zn)		ppm						
Manganese (Mn)		ppm						
Iron (Fe)		ppm						
Copper (Cu)		ppm						

Organic matter % | Neutralizable acidity meq 100g | Cation Exchange Capacity meq 100g
Sodium (Na) lbs a | Electrical Conductivity mmho cm

SUGGESTED ANNUAL TREATMENTS: Cropping options	Yield goal	Pounds per acre: N	P_2O_5	K_2O	Zn	S

LIMESTONE SUGGESTIONS
Effective neutralizing material (ENM)
Effective magnesium (EMg)

Figure 1. Sample soil test report form.

Soil test results and ratings

pH_s. The salt pH (pH_s) of a soil indicates the level of active soil acidity. Crops require different salt pH levels for the best growth and optimum production in terms of yield and economic costs. For example, many row crops, small grains and legume-grass mixtures should be maintained in soils with a salt pH between 6.1 and 6.5.

Alfalfa requires a slightly higher salt pH of 6.6 to 7.0. Many pure grass stands do well in soils with a salt pH of 5.5 to 6.0.

Crop production may be severely reduced in soils with a salt pH at or below 5.0. As soil salt pH falls below 5.0, aluminum and manganese may increase to toxic levels. Also, phosphorus and molybdenum availability decreases as soil becomes more acid.

Maintained at a salt pH between 5.5 and 7.0, Missouri soils provide a favorable environment for root development and microorganisms (the living part of the soil). They also provide field crops with the best nutrient availability for growth.

Limestone recommendations are made to correct the problems of soil acidity. These recommendations are based on the soil tests, crops to be grown, and the region of the state the sample comes from. See MU publication G9102, *Liming Missouri Soils,* for more information.

Phosphorus (P). In Missouri, the soil test for phosphorus is called the Bray and Kurtz I or Weak Bray test. The test results are expressed in pounds of elemental P per acre. This test is a measure of the relative availability of phosphorus for plant growth. The test does not measure the total amount of phosphorus in the soil.

A *very low* or *low* test indicates that crops would very likely respond to the addition of phosphorus fertilizer. Under low soil test conditions, banding a portion of the recommended phosphate may be advantageous.

A soil testing *medium* in phosphorus means that crops are likely to respond to phosphate, if growing conditions are favorable for high yields.

Soils testing *high* in phosphorus are not likely to produce economic yield increases with an application of additional phosphorus. In fact, it would cost more to fertilize than you would get back in profits from increased yield. When soils test in the high range, applying only a small quantity of phosphorus is suggested to maintain the high fertility status.

There is no economic advantage to applying phosphate to soils testing *very high*. The University of Missouri does not suggest applying phosphorus on soils testing very high in phosphorus.

An adequate phosphorus soil test range for row crops and small grains is about 45 to 70 pounds P per acre. Most forage crops do well in a soil testing in a range somewhat lower.

An adequate range is 40 to 60 pounds P per acre. Rice, birdsfoot trefoil-grass mixtures, lespedeza-grass mixtures, and bermuda grass require soil testing in a range of only about 30 to 45 pounds of P per acre for economical production. Native warm-season grasses do well on soils testing 20 to 35 pounds of P per acre.

CEC. The Cation Exchange Capacity is a measure of the soil's ability to hold certain nutrients known as *cations*. The CEC on the soil test report is a calculation of the exchangeable calcium, magnesium, potassium, and hydrogen measured by the soil tests. This calculation is given in milli-equivalents (me.) per 100 grams of soil. The CEC value helps technicians make the potassium and magnesium interpretations and estimate the soil texture.

Potassium (K). This is a measure of the exchangeable potassium in soil extracted with an ammonium acetate solution. The results are expressed as pounds of exchangeable K per acre. The soil test estimates the potassium available to the growing crop.

The exchangeable potassium test and CEC are used to interpret the need for additional potassium. In most Missouri soils, the desired level of potassium increases as the CEC increases.

The ratings of the potassium soil test levels are similar to those made for phosphorus. *Very low* to *low* soil K levels strongly indicate that crops will respond to the application of potassium. Band application of a portion of the total requirement may also be advantageous.

Medium soil K levels indicate that crops may respond to potassium if climatic conditions are favorable.

Soils with *high* K levels are not likely to respond to application, but they should be maintained at this level. *Very high* to *excess* soil K tests show that you can allow crops to deplete potassium until the soil test drops into the high range.

The optimum potassium level for row crops, small grains and alfalfa hay is (220 + (5 x CEC)) pounds K per acre. Table 1 gives the adequate soil K ranges for different soil textures and crops. Within these ranges, it is recommended to apply a small quantity of potassium to maintain the high fertility status.

Table 1. Adequate soil potassium ranges based on soil texture and crops grown.

	Soil texture				
	Sand	**Sandy loam**	**Silt loam**	**Clay loam**	**Clay**
Crops	**Adequate potassium soil test ranges (lbs. K/A)**				
Alfalfa hay, row crops, small grains	240-360	260-390	290-435	320-480	350-525
Alfalfa-grass pasture and all other forages	180-270	200-300	230-345	260-390	290-435

Calcium (Ca). An ammonium acetate solution extracts exchangeable calcium from the soil. Calcium seldom limits crop growth in Missouri soils. Even very highly acid soils needing lime usually contain enough calcium as a plant nutrient for crops. The soil calcium measurement is used to calculate CEC.

The calcium rating is not based on the actual soil test calcium level. A very low to low soil salt pH_s (acid soil) is rated *medium* in calcium. Medium or high soil pH_s (near neutral soil) is rated *high* in calcium.

Magnesium (Mg). An ammonium acetate solution extracts exchangeable magnesium from the soil.

Application of magnesium based on soils testing *very low* to *low* may improve yields in some forages and row crops. Application on soils testing *medium* is not likely to increase yields in row crops and small grains. However, application may increase magnesium levels in forages and improve forage quality. When magnesium is needed and lime is required, the use of dolomitic limestone is recommended.

For more information on magnesium requirements, see MU publication G9102, *Liming Missouri Soils*.

Organic matter (O.M.). The organic matter soil test is used to estimate potential nitrogen release to a crop throughout the growing season. The test also provides a basis for determining proper herbicide rates.

There is no rating system for organic matter because it is relatively stable under normal cropping and fertility practices and cannot be easily changed.

Neutralizable acidity (N.A.). Technicians add a buffer solution to the sample used for salt pH analysis to estimate the neutralizable acidity of the soil. Neutralizable acidity is a measure of the exchangeable hydrogen within soil. It is used to calculate the pounds of effective neutralizing material necessary to lime the soil to the proper salt pH range. See MU publication G09102, *Liming Missouri Soils*.

Determining suggested fertilizer rates

Nitrogen (N). To calculate nitrogen needs, the yield goal should be realistic, based on crop yield history of the field, irrigation, and your own managerial skills.

To calculate nitrogen needs for a crop:

- Multiply the nitrogen in the harvested portion of the crop (grain for example) by the yield goal you choose.
- Add to that the nitrogen needed to grow the vegetative portion of the crop.
- From this amount, subtract the nitrogen your soil will supply (based on the organic matter soil test).

Table 2. Nitrogen rate adjustments[1].

Soil texture	Cation exchange capacity (me/100 g.)	Organic matter (%)	Cool-season crops (lbs. N/A)	Warm-season crops (lbs. N/A)
Sands — sandy loam	less than 10	0.5 1.0 1.5	10 20 30	20 40 60
Silt loams — loam	10 to 18	2.0 3.0 4.0	20 30 40	40 60 80
Clay loams — clays	greater than 18	2.0 3.0 4.0 5.0	10 15 20 25	20 30 40 50
[1]Based on soil texture, organic matter and time of major growth.				

An example calculation for nitrogen requirement on corn:

Plant population (1,000 ft./acre) = 20 x 4 = 80
Expected yield (bu./acre) = 150 x 0.9 = 135 Total
nitrogen required = 215
Soil nitrogen release Texture = Silt loam Organic
matter (from Table 2) = 2.0% = -(40)
Credit from previous legume crop = Soybeans - 40 bu = -(40) Credit
from manure application = none applied = -(0) Additional fertilizer
requirement (lbs. N/A) = 135

In this example, the final corn population was expected to be 20,000 plants per acre. Multiply this value by 4 pounds of nitrogen per 1,000 plants. That's only the amount of nitrogen needed to grow the crop. The expected yield is 150 bushels per acre. This yield times 0.9 pounds of nitrogen per bushel, plus the nitrogen to grow the crop, indicates the total nitrogen required (from fertilizer, previous legumes, or manures). From the total nitrogen required, subtract all credits to determine the nitrogen fertilizer requirement.

The suggested rate of application accounts for the total nitrogen required and the soil nitrogen release. You must account for additional nitrogen reductions, such as any previous legume crops or manure application. Consider these sources of nitrogen when you determine how much nitrogen to apply for a crop. For example, you may reduce nitrogen rates by about 30 pounds per acre for a crop following soybeans. A good guideline is to reduce about 1 pound of nitrogen for each bushel of the previous soybean crop. Table 3 shows reasonable nitrogen adjustments for a crop following a legume under the best growing conditions.

Manure applications also supply nitrogen. Although the pounds of available nitrogen per ton of dry manure may vary greatly, you can usually reduce nitrogen rates by about 10 to 15 pounds per ton of dry manure.

Table 3. Nitrogen added to the soil by a legume crop (optimum).

Legume crop	**Nitrogen added (lbs. N/acre)**
Alfalfa 80-100% stand 50-80% Less than 50%	 120-140 40-60 0-20
Sweet clover (green manure)	100-120
Red clover (pure stand)	40-60
Soybeans	15-60
Adapted from Follett and Hunter, 1977. *Proper fertilizer management saves energy*. Kansas State University Publication MF-449.	

Phosphorus. Suggested phosphorus rates either build up or maintain the level of phosphorus in the soil. Soils depleted of phosphorus require building up phosphorus for optimum production. If the soil already has an optimal level of phosphorus, the soil test report suggests a maintenance application. Soils testing higher than optimum do not usually respond to application, so you can allow the phosphorus level to drop to the optimal range.

Phosphorus needs are based on the level required to build up the soil to optimum availability for crop growth. Suggested fertilizer rates are also based on the amount of phosphorus removed from the soil by harvested crops. Table 4 shows the rates necessary to build up phosphorus to an optimal level with one application.

Table 4. Phosphorus rates required for build-up treatments in eight years.

The University of Missouri presently suggests spreading this build-up over about an 8-year period to reflect expected economic returns from fertilizer application rates.

Soil test level (lbs. phosphorus/acre)	Optimal soil test level (lbs. phosphorus/acre)		
	30	40	45
	(lbs. phosphate/acre)		
5	45	56	61
10	32	43	49
15	22	34	39
20	14	25	31
25	7	18	24
30	—	12	17
35	—	6	11
40	—	—	5

Table 5 shows how much phosphorus is removed by some crops. With this information, you can determine the suggested phosphorus rate by knowing the optimal soil test level, your actual soil test level, and expected crop yield.

Table 5. Phosphorus and potassium removed by various crops.

Crop and yield	Crop removal	
	lbs. phosphate/acre	lbs. potash/acre
Soybeans at 40 bushels/acre	34	58
Corn (grain) at 100 bushels/acre	45	30
Corn (silage) at 15 tons/ acre	54	135
Wheat at 60 bushels/acre	36	18
Alfalfa at 4 tons/acre	40	180
Fescue hay at 4 tons/acre	36	136

Calculating a phosphorus treatment. Suppose the soil test is 20 pounds of P, and your yield goal is 150 bushels of corn an acre.

Building up your soil from 20 to 45 requires 245 pounds of phosphate fertilizer. This 245-pound build-up spread over eight years means that you would apply about 31 pounds phosphate annually (see Table 4).

Growing 150 bushels of corn per acre removes about 67 pounds of phosphate. So the suggested phosphorus rate would be: 31 + 67 = 98 lbs. phosphate per acre.

Potassium. Suggested application rates of potassium are based on amounts needed to build up the soil to the desired level. The rate suggested includes the amount removed by the harvested crop. Table 6 gives the rates necessary to build up soil potassium in one application.

Fertilizer recommendations are presently based on building up soil potassium in eight annual applications.

Table 6. Potassium rates required for build-up treatments in eight years.

Calculating a potassium requirement. Suppose the soil test is 250 pounds of potassium per acre and the optimal soil test level is 300 pounds of potassium per acre (based on soil texture and CEC). The yield goal is 150 bushels of corn an acre.

Soil test level (lbs. potassium/acre)	Optimal soil test (lbs. potassium/acre)					
	200	240	260	280	300	340
	(lbs. potash/acre)					
100	39	52	58	64	69	80
150	18	31	36	42	48	58
200	—	13	19	24	30	41
250	—	—	3	9	14	25
300	—	—	—	—	—	11

The potassium rate to build up the soil from 250 to 300 is 114 pounds potash an acre (see Table 6). This 114-pound build-up spread out over eight years means that you would apply 14 pounds potash an acre annually.

Growing 150 bushels of corn per acre removes 45 pounds of potash per acre (see Table 4). So the suggested rate would be: 14 + 45 = 59 pounds potash per acre.

Zinc (Zn). You should have the zinc soil test performed:

- on land leveled for irrigation or on recently graded terraces
- on extremely sandy soils
- on soils with high to excessive phosphorus levels
- on soils under irrigated intensive crop production

In Missouri, a zinc application is likely to increase corn and grain sorghum yields. Table 7 shows ratings and suggested application rates for these two crops, based on the DTPA extractable zinc soil test level.

Table 7. Suggested zinc application rates on corn and sorghum.

Soil test level (ppm Zn)	Rating	Zinc application rate (lbs. Zn/acre)
Less than 0.5	Low	10
0.5-1.0	Medium	5
Greater than 1.0	High	0

Most row crops, small grains and alfalfa are less likely to respond to zinc fertilization compared to corn or sorghum. Therefore, zinc is recommended for those crops only when the soil test is less than 0.5 ppm. Five pounds actual zinc per acre should be adequate for those crops under the low zinc test level situations.

The suggested zinc applications should correct zinc deficiency and maintain available zinc at an adequate level for at least four crop years. Zinc sulfate or zinc oxide are adequate fertilizer sources for zinc. If you plan to use zinc chelate, apply 1/3 to 1/2 of the recommended rate annually.

Sulfur (S). Crops may respond to sulfur applied on coarse-textured soils low in organic matter that have been producing high yields. As the soil sulfate-sulfur level or cation exchange capacity increases in soils, the potential response to sulfur decreases. Table 8 outlines sulfur interpretations, based on soil sulfate-sulfur and cation exchange capacity. When these tests show a need for fertilizer sulfur, 10 to 20 pounds of sulfur is suggested for row crops, small grains and alfalfa. In Missouri, most other forages do not require sulfur, even on soils testing low in sulfur.

Table 8. Ratings of extractable soil sulfur test.

Soil sulfate-sulfur (ppm SO_4-S)	Cation exchange capacity (meq/100 g)	
	0 to 6.5	6.5+
0 to 7.5	Low	Adequate
7.5 +	Adequate	Adequate

Additional micronutrients. The potential for economic response to applications of iron, manganese or copper is not likely with Missouri soils. However, many growers have questions about the level of these nutrients in their soils. Soil tests for iron, manganese and copper are available through the University of Missouri soil testing labs. Presently, field research has not shown a need for application of these micronutrients in Missouri or on similar soils in neighboring states. Table 9 outlines current DTPA soil test interpretations for these three micronutrients.

Table 9. Iron, copper and manganese soil test interpretations.

Soil test rating	Iron	Copper	Manganese
	DTPA extractable soil test level (ppm)		
Low	0-2.0	0-0.2	0-1.0
Medium	2.0-4.5	—	—
High	4.5+	0.2+	1.0+

In areas of the United States where deficiencies of these micronutrients have occurred, the following treatments are the most effective:

- Iron: Foliar sprays of 0.5 to 3.0 pounds of iron per acre are the most effective. Soil applications are not as consistent in correcting iron deficiencies. Applying farmyard manure best achieves long-term correction.
- Copper: Copper is least likely to show up as a deficiency on our mineral soils in Missouri. Foliar applications according to manufacturer suggestions should be adequate.
- Manganese: Foliar or band applications of manganese at 1 to 2 pounds of manganese per acre should correct deficiencies that may occur.

No soil tests for boron or molybdenum are currently offered by the University of Missouri. In Missouri, apply boron annually to alfalfa at a rate of about 1 pound of boron per acre to avoid deficiency. Liming soils to a salt pH of 5.5 or greater should avoid any potential deficiency of molybdenum on any crop grown in Missouri.

University of Missouri. Published by University Extension, University of Missouri-Columbia. Issued in furtherance of Cooperative Extension Work Acts of May 8 and June 30, 1914, in cooperation with the United States Department of Agriculture. Ronald J. Turner, Director, Cooperative Extension Service, University of Missouri and Lincoln University, Columbia, Missouri 65211. • UniversityExtension does not discriminate on the basis of race, color, national origin, sex, religion, age, disability or status as a Vietnam-era veteran in employment or programs. If you have special needs as addressed by the Americans with Disabilities Act and need this publication in an alternative format, write ADA Officer, Extension and Agricultural Information, 1-98 Agriculture Building, Columbia, MO 65211, or call (573) 882-7216. Reasonable efforts will be made to accommodate your special needs.