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MONTANA STATE UNIVERSITY EXTENSION

MontGuide

Home Garden Soil Testing & Fertilizer Guidelines

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Soil testing and interpreting your soil test results are useful for developing fertilizer rates specific to your garden.

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THE PURPOSE OF THIS GUIDE IS TO PROVIDE home gardeners and Extension agents with the tools to better understand and interpret soil test reports. This is necessary to more accurately determine fertilizer rates and any need for soil amendments, such as compost. The data in these reports are only worthwhile if the tested soil sample accurately represents the sampled garden; therefore, a summary of sampling methods is provided.

Soil Testing Versus Standard Fertilizer Rates

It should be noted that due to time and the cost of soil analysis ($20-$50) compared to the cost of fertilizer (due to generally small yard areas), many gardeners do not sample but instead use standard fertilizer rates (Table 1 on page 2) which are often given on fertilizer bags. If you are using standard fertilizer rates and your plants appear healthy, we recommend continuing your current fertilizer regimen and soil sample only if you wish to reduce the risk of, or diagnose, a potential nutrient deficiency or toxicity. If you have been using standard fertilizer rates and your plants have notable visual or growth problems, soil testing may be the only way to determine if your garden has abnormal levels of nutrients. Although it is often thought that "more is better", gardens can have excessive nutrient levels due to high inputs of compost and/or fertilizer. Excessive levels of fertilizer are not only a waste of money, but can be harmful to the environment.

Please see the *Montana Master Gardener Handbook* for more information on standard fertilizer types and amounts for gardens, lawns, shrubs and trees. See "Extension Materials" at the back of this publication for web address and ordering information for all Extension documents referenced in this MontGuide.

Soil Sampling

To obtain meaningful and accurate soil test results, it is important that you collect soil samples from the correct depth and from multiple locations within your yard and garden. You should schedule soil sampling to allow adequate time for soil analysis (~1-2 weeks) and fertilizer purchase prior to application. To obtain a representative soil sample, a minimum of ten samples should be collected and mixed from both your garden and each 1,000 square feet (sq ft) of lawn. Be sure to remove any mulch or lawn thatch before collecting your soil samples. If there is a visual or textural difference from one side of your garden or lawn to the other, submit separate samples. Samples may be submitted moist or dry. If you decide to soil sample in the fall or mid-summer, it is best to wait at least 2 months after fertilization to give the fertilizer a chance to dissolve, disperse and be used by plants.

Soil samples are typically collected using hand probes, hand augers (Figure 1), spades or shovels. Unless it is the only option, you should avoid shovels and spades because it is difficult to obtain the same amount of soil from each depth and location, possibly biasing results. Hand augers are useful, especially when sampling at different depths. An alternative tool to collect a 0 to 6 inch soil sample is a bulb planter (available at most gardening stores). Preferably, many Extension offices have hand probes or augers and may either lend you the tools or assist you in soil sampling. Tools should be cleaned between each garden or area sampled and stored away from fertilizers to prevent contamination.

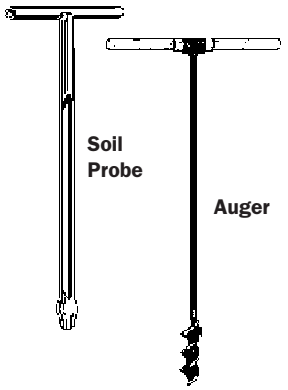

Figure 1. Soil sampling hand probe and auger.

Table 1. Standard rates of fertilizer for lawns, gardens and shrubs/trees.

	Total Amount	Amount per Application	Notes
Lawn	3 lb N per 1000 sq ft per year	1 lb N per 1000 sq ft	Apply Memorial Day, Labor Day and Columbus Day
Garden	20 lb 10–10–10 per 1000 sq ft per year	10 lb 10–10–10 per 1000 sq ft	Apply prior to planting and later between rows to avoid plant burning
			Apply 3rd application for high N demanding plants[a]
Shrub/Tree	1 lb of 10–10–10 per inch diameter at breast height or 1 lb N per 1000 sq ft drip line	1 lb of 10–10–10 per inch diameter at breast height or 1 lb N per 1000 sq ft drip line	No need for additional fertilizer if plant lies within your fertilized lawn

[a]Beets, corn, onions, potatoes, rhubarb, spinach, strawberries, sunflowers and tomatoes

Sampling Depth

For home gardens, lawns and trees, soil samples are generally collected 0 to 6 inches from the soil surface. In some cases, soil samples may, in addition, be taken below the 6 inch depth. Because nitrogen (N) (in the form of nitrate-N), sulfate-sulfur (sulfate-S) and chloride (Cl) are very soluble and can more readily move down into the soil than other nutrients, deeper soil samples may be collected and analyzed for these nutrients.

Sampling Time

Ideally, soil sampling occurs yearly in the spring to best estimate growing season nutrient availability; however, due to time constraints and soil conditions, it may be more practical to test soil in the fall. Testing in the fall does not always capture the true amount of N that will be available at planting, because some N is released from organic matter (O.M.) during the winter months in a process called "mineralization". Fall N levels will be similar to spring N levels if the fall and winter are cold and dry, because both conditions essentially stop N mineralization. Please contact your local Extension agent for specific information on soil sampling or refer to MSU Extension Service's Nutrient Management (NM) Modules (#4449).

Soil Testing Laboratories

The time spent selecting a good laboratory can quickly pay for itself in the form of accurate fertilizer recommendations and desired plant responses. Laboratories that are part of the North American Proficiency Testing Program (NAPTP) should provide you with results from their analysis of NAPTP soil samples that have known nutrient levels. A fairly high degree of variability has been observed among laboratories (Jacobsen et al., 2002); therefore, it is recommended that soil samples be sent to the same laboratory each year to ensure greater consistency. A list of analytical laboratories in the region may be found in the Appendix.

Some laboratories have standard packages that indicate what nutrients and other soil parameters are tested. It is recommended that, at a minimum, N, phosphorus (P), potassium (K), O.M., soluble salts and pH be tested.

Tissue Sampling

In Montana, plant tissue sampled periodically during the growing season and tested for nutrient deficiencies has often led to inconsistent results, due to inconsistent tissue sampling, handling, preparation and shipping (Jackson, pers. comm.). Because it takes a couple of weeks between sending tissue samples, receiving test results and purchasing/applying fertilizer, plant growth may have already been decreased by the time that fertilizer is applied. Therefore, it is recommended that you identify potential nutrient deficiencies by soil testing prior to the growing season.

If you do decide to tissue test, please contact your local Extension agent for specific information on tissue sampling and sample preparation. If plant tissue is exhibiting nutrient deficiency symptoms, samples from plants with deficiency symptoms should be collected along with samples from healthy plants, either from your garden or a neighbor's, for comparison. Although most soil testing laboratories will test tissue samples, it is best to check first. If sufficiency ranges are not provided by the laboratory, you can likely find sufficiency ranges on the Internet or in textbooks to compare with your tissue test results; however, these values have been determined for other regions, and not for Montana. Therefore, comparing your nutrient levels with healthy plants is likely the best strategy.

Again, tissue analysis should only be used to supplement a routine soil test done prior to the growing season. Tissue testing determines the availability of nutrients prior to the time that the test was taken; it is not a good estimate of current fertilizer needs.

Soil Test Data Interpretations and Fertilizer Guidelines

An example soil test report is shown in Figure 2. Each laboratory uses a somewhat different format, but the overall information is generally similar.

Macronutrients

Macronutrients that may be tested in your soil include N, P, K, S, calcium (Ca) and magnesium (Mg). Nitrogen, P and K are considered "primary" macronutrients because

they are required in higher quantities and are deficient more often than S, Ca and Mg ("secondary" macronutrients). In general, Ca and Mg are present in quantities well above necessary levels in Montana soils. Although Montana soils have plenty of Ca, water is needed to move Ca through the plant and dry soil may result in a deficiency within the plant. Plants with Ca deficiency can be more susceptible to blossom end rot (BER). Refer to Growing Tomatoes in Montana (MT199217AG) for more information on BER.

Nitrogen

In soil tests, N is generally measured as and reported as nitrate-N (NO_3-N) in pounds of N per acre (lb N/acre), because nitrate-N is the most soil available form of N. For the remainder of the document, nitrate-N will be referred to as N. High rainfall or watering can lower amounts of soil N by leaching it, whereas O.M. decomposition can increase soil N. Therefore, soil N tests are representative of current N levels and do not necessarily reflect future conditions. There is no single recommended N level, because N requirements vary among plants.

As mentioned previously, available N levels can increase between fall and spring sampling. For example, based on a study by Miller et al. (2006), three Montana soils with an average of 1.8% O.M. had soil N levels about 0.6 lb N/1000 sq ft higher in the spring than late summer/early fall. Therefore, if soil is tested in the late summer, your fertilizer rate in the spring of the following year can be decreased by about 0.6 lb N/1000 sq ft. The difference between spring and fall N levels should be higher with higher O.M. levels (i.e. greater amounts of released N) and dependent upon what plants you grew the previous year (i.e. heavy N feeders (Table 1) versus soil N contributors, such as peas) and fall/winter weather conditions (warm and moist will release the most N).

To illustrate how to determine fertilizer rates from your soil test report, refer to the Calculation Box, Table 2 and the sample soil test report (Figure 2). Keep in mind that the guidelines shown in this document are for the entire state of Montana and the guidelines may need to be adjusted specifically for your location. For example, if you are in a warmer location, you should likely increase your fertilizer amounts due to higher plant growth and nutrient needs; conversely, if you are in a cool area, you should slightly decrease your fertilizer amounts. Similarly, if your plants receive less water than they need, you should reduce your fertilizer rates.

Phosphorus and Potassium

Unlike N, P and K are highly immobile in the soil, making them less plant-available, P being much more immobile than K. Montana has among the lowest soil test P levels in the country (PPI, 2005), demonstrating that Montana soils often have low P availability. Calcium, which is prevalent in most Montana soils, ties up P, making it relatively unavailable to plants.

Table 2. Home landscape and nitrogen fertilizer guidelines based on soil test results and organic matter level.

Soil Test		Organic Matter (%)		
Nitrate-N[a]	Location	< 1.5	1.5 – 3. 0	> 3.0
lb/acre		lb N/1000 sq ft		
< 20	Lawns	6	5	4
	Trees/Shrubs[b]	3	2	2
	Garden	4	3	3
20 – 40	Lawns	4	3	2
	Trees/Shrubs[b]	2	1	1
	Garden	2	2	2
> 40	Lawns	2	1	1
	Trees/Shrubs[b]	1	0.5	0
	Garden	1	1	0.5

[a]0-6 inch sample depth
[b]No need for additional fertilizer if located within a fertilized lawn

Figure 2. Sample soil test report and fertilizer recommendations.

Name: Homeowner		**Sample Date:** April 9, 2007	
Lab Number: 12345		**Your Sample Number:** 1	
Crop to be Grown: Garden		**Sampling Depth:** 0 to 6 inches	
Soil Test Results		**Interpretation**	**Recommendation**
Nitrate-N	12 lb/acre 6 ppm	Low	3 lb N/1000 sq ft
Olsen Phosphorus	15 ppm	Medium	2 lb P_2O_5/1000 sq ft
Potassium	192 ppm	Medium	1 lb K_2O/1000 sq ft
Sulfate-S	15 ppm	High	————
Boron	0.5 ppm	Medium	0.02 lb B/1000 sq ft
Copper	1.7 ppm	Very High	————
Iron	47 ppm	Very High	————
Manganese	10 ppm	Very High	————
Zinc	1.3 ppm	High	————
Soluble Salts	0.3	Low	————
Organic Matter	3.4%	Medium	————
Soil pH	7.7	Medium/High	————
CEC	17.8	Medium	
Soil Texture	Sandy Loam		

Calculation Box. Fertilizer requirements for the home garden based on nitrogen needs from the sample soil test report (Figure 2).

Nitrogen requirement for soil with 3.4% organic matter and 12 lb N/acre (<20 lb N/acre): **3 lb N/1000 sq ft** (Table 2)

APPLICATION RATE:
Using a fertilizer blend of 10–15–10[a], meaning 10% N (0.10 lb N/lb fertilizer), 15% P_2O_5 and 10% K_2O

To calculate the amount of 10–15–10 fertilizer to apply:
(Required Amount of N) ÷ (Amount N/lb Fertilizer) = Amount of Fertilizer to Apply/1000 sq ft
(3 lb N/1000 sq ft) ÷ (0.10 lb N/lb fertilizer) = **30 lb of 10–15–10/1000 sq ft**

To calculate amounts of P and K added in 30 lb of 10–15–10/1000 sq ft:
Fraction of P_2O_5 in 10–15–10 Fertilizer = 15% = 0.15 P_2O_5/lb Fertilizer
30 lb of 10–15–10/1000 sq ft x 0.15 = **4.5 lb P_2O_5/1000 sq ft**

Fraction of K_2O in 10–15–10 Fertilizer = 10% = 0.10
30 lb of 10–15–10/1000 sq ft x 0.10 = **3 lb K_2O/1000 sq ft**

[a]Grade should be selected to best match the amount of N, P and K recommended in your soil test report

There are three major soil tests used for available P: the Bray-1 and Mehlich-3 tests for acidic soils, and the Olsen P tests for neutral to alkaline soils. In Montana's alkaline soils, P is typically tested using Olsen P, also known as bicarbonate P. Unfortunately, Bray and Mehlich test results do not convert easily to Olsen P, and because P fertilizer guidelines in Montana are based on Olsen P, you should ask your soil testing lab to only test for Olsen P. In addition, Olsen P is fairly robust and does work below pH 7. Bray, however, does not work well at higher pH (>7).

Over the growing season, K is removed from solution and from the edges of soil particles by plants, so K soil tests will be lower in late summer. Highest and most accurate K levels will be measured in the spring just after the soil thaws and before plant uptake becomes substantial; therefore, it is recommended that soil be tested for K in the spring. Plants can continuously absorb K beyond plant requirements, and high levels of K can result in other nutrient deficiencies, so it is important to test soil for K to reduce over-fertilization. See Tables 3 and 4 for recommended P and K fertilizer guidelines.

Sulfur

Unfortunately, in many Montana soils responses to S fertilizer are much less consistent than for P and K, partly because concentrations of available S below typical sampling depths can be very high due to high levels of gypsum ($CaSO_4 \cdot 2H_2O$). In addition, soil tests for S sometimes do not accurately reflect S availability. Due to these inconsistencies, MSU does not have S guidelines based on soil tests.

The highest likelihood of S increasing plant growth occurs on coarse (sandy), shallow soils as these soils generally do not contain much gypsum and have trouble retaining the S that is present. The best way to determine if your plants have an S deficiency is to see if there is uniform yellowing on the youngest leaves of your plants. If S is needed, it is recommended that 0.3 to 0.5 lb of S/1000 sq ft be applied.

Micronutrients

Mineral micronutrients, naturally present in the soil, are required by plants in lower quantities than macronutrients and are no less important. They include boron (B), chloride (Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), nickel (Ni) and zinc (Zn). In general, Ni and Mo are present in quantities well above necessary levels in Montana soils and will not be discussed further. Because micronutrient deficiencies are uncommon, there has been little work

Table 3. Home gardener phosphorus fertilizer guidelines based on soil tests.

Olsen P[a]	Gardens	Lawns	Trees/Shrubs
ppm	———lb P_2O_5/1000 sq ft———		
< 4	5	3	3
4 – 8	4	2	2
8 – 12	3	1	1.5
12 – 16	2	0	1
> 16	1	0	0

[a]Sodium bicarbonate extractable P, 0-6 inch sample depth

Table 4. Home gardener potassium fertilizer guidelines based on soil tests.

Soil test K[a]	Gardens	Lawns	Trees/Shrubs
ppm	———lb K_2O/1000 sq ft———		
< 75	3	4	2
75 – 150	2	3	1
150 – 250	1	2	0.5
> 250	0	1	0

[a]Ammonium acetate extractable K, 0-6 inch sample depth

in Montana to determine plant-specific micronutrient requirements. However, Table 5 lists the general ranges for Montana's micronutrient levels (for B, Cu, Fe, Mn and Zn) to assist in determining if fertilizer is needed. Applying metal micronutrient (Cu, Fe, Mn and Zn) fertilizers either in a band 1 to 2 inches below the seed ("banding") or on the leaves ("foliar applications") is recommended over surface applications, because metals are very immobile in the soil, decreasing the chance they will make it to the roots. Some plants are more prone to micronutrient deficiencies than others. For example, Fe deficiencies are very common in members of the Rose family, in addition to ash, apple, crabapple and some maple trees.

Organic Matter

In soil, O.M. consists of partially decomposed plant (and animal) material, such as roots, grass clippings and tree leaves. A 2% O. M. content, measured and recorded in your soil test report, is considered adequate for soil tilth and O.M. is generally at least this high in gardens from additions of O.M., such as compost. Low O.M. reduces the nutrient contribution from the soil, possibly causing nutrient deficiencies. In addition, percentages below 2% cause the soil to hold less water and possibly erode more. Manure compost is the most common amendment used in Montana gardens to increase O.M.; however, adding ground bark or peat moss is also generally worthwhile. As a cautionary note, O.M. additions that increase the O.M. content above about 8% may be harmful, particularly if manure was the major O.M. source. Generally, manure has very high levels of P and K, therefore, high amounts of manure may result in excessive levels of P and K.

To avoid the possibility of an N deficiency caused by decomposition of bark mulch, which is low in N, add about 24 pounds of actual N to each ton of mulch. For example, for each ton of mulch added, you will need to apply 80 pounds of 30-10-10, 240 pounds of 10-10-10 or about 150 pounds of 16-16-16 fertilizer per 1000 sq ft (Moore-Gough et al., 2006). "Grade" (the three numbers on a fertilizer bag) equates to the percentage of total N, available P (in the form of P_2O_5) and soluble K (in the form of K_2O) present. If a fertilizer is labeled 30-10-10, it contains 30% N, 10% P_2O_5 and 10% K_2O.

Soil pH

Soil pH is a measure of soil acidity or alkalinity. The pH scale ranges from approximately 0 to 14, with 7 being neutral. Values less than 7 are acidic and values greater than 7 are alkaline. Different plants thrive best at different soil pH ranges. For example, conifers thrive in acidic soils with a pH range between 6 (somewhat acidic) and 7.5 (slightly alkaline), whereas vegetables, grasses and most ornamentals do best in a pH range of 5.8 to 6.5. Soil pH values above or below these ranges may result in less vigorous growth and more nutrient deficiencies. In eastern Montana, surface soil pH is typically between 7 and 8, while western Montana soils tend to be slightly more acidic. Maximum nutrient availability occurs when pH is optimal for the soil nutrient (Table 5). Soil pHs outside of these optimal ranges may cause nutrients to be less available to plants, potentially resulting in deficiencies. Unfortunately, due to Montana's well buffered soils, it is very difficult, and generally expensive, to lower soil pH. Additions of elemental S are the most common strategy, but rates near 225 lb S/1000 sq ft have only been found to lower pH from 7.9 to 7.5 (Agvise Laboratories, ND). Additions of O.M. will generally lower soil pH over time, however, while the addition of some O.M. sources lower pH, not all sources are effective. Many manure sources within Montana and Wyoming are alkaline ("they are what they eat") and may not effectively acidify soils to the degree desired.

Cation Exchange Capacity (CEC)

This parameter is only occasionally tested. The cation (positively charged particle) exchange capacity (CEC) is directly affected by soil pH and is a good measure of the soil's ability to retain and supply nutrients to plants. A high CEC is desired and is indicative of a high capacity for the soil to hold nutrient cations (e.g. K^+ and NH_4^+). A CEC above 10 "milliequivalents" per 100 grams (10 meq/100g) is considered adequate. Increasing the O.M. of any soil will increase the CEC.

Table 5. Soil nutrient classes, toxicity levels and optimal pH. All levels that are displayed are for soil collected in the 0 – 6 inch soil depth.

Nutrient	Low Levels	Medium Levels	High Levels[a]	Toxicity Levels	Optimal pH
	ppm				
Nitrogen (N)	NA[b]	NA[b]	NA[b]	NA[c]	6.5 – 8
Phosphorus (P)	< 8	8 – 16	> 16	NA	6.5 – 8
Potassium (K)	< 150	150 – 250	> 250	800[d]	6.5 – 8
Sulfur (S)	NA	NA	NA	NA	6.5 – 8
Boron (B)	< 0.5	0.5 – 1.0	> 1.0	5[e]	5 – 7
Chloride (Cl)	NA	NA	NA	NA	5 – 7
Copper (Cu)	< 0.25	0.25 – 0.5	> 0.5	NA	5 – 7
Iron (Fe)	< 2.5	2.5 – 5.0	> 5.0	NA	5 – 7
Manganese (Mn)	< 0.5	0.5 – 1.0	> 1.0	NA	5 – 7
Zinc (Zn)	< 0.25	0.25 – 0.5	> 0.5	60[f]	5 – 7

[a]Comparable to critical levels [b]Plant dependent [c]Plant and soil moisture dependent [d]Marx et al. (1999)
[e]Westerman (1990) [f]D. Neuman, pers. comm. NA – not available

Table 6. Amount of various fertilizers needed to apply specific rates of actual nitrogen, phosphorus and potassium.

Fertilizer Grade	Pounds actual N/1000 sq ft			Pounds actual P_2O_5/1000 sq ft			Pounds actual K_2O/1000 sq ft		
	1	2	3	1	2	3	1	2	3
N – P_2O_5 – K_2O	**—lb fertilizer/1000 sq ft–**			**—lb fertilizer/1000 sq ft—**			**—lb fertilizer/1000 sq ft—**		
2–3–2	50	100	150	33	67	100	50	100	150
4–10–4	25	50	75	10	20	30	25	50	75
6–10–4	17	33	50	10	20	30	25	50	75
8–10–8	13	25	38	10	20	30	13	25	38
10–10–15	10	20	30	10	20	30	7	13	20
12–12–5	8	17	25	8	17	25	20	40	60
15–10–0	7	13	20	10	20	30	—	—	—
16–20–0	6	13	19	5	10	15	—	—	—
20–16–0	5	10	15	6	13	19	—	—	—
20–0–0	5	10	15	—	—	—	—	—	—
34–0–0	3	6	9	—	—	—	—	—	—
46–0–0	2	4	7	—	—	—	—	—	—

Soluble Salts

High levels of soluble salts, sometimes referred to as "EC" (electrical conductivity) on a soil test report, can cause water stress and nutritional imbalances in plants. Generally, seedlings are more sensitive than established plants to elevated soluble salt levels. Values higher than 4 (units are either "millimhos per centimeter" (mmhos/cm) or "deci siemens per meter" (dS/m)) may damage plants, though, some plants are more tolerant to salts than others. A soluble salt level will be lower following precipitation or leaching with liberal amounts (2 to 4 inches) of tap water, therefore, consider sampling a few times per year to verify that you have a salt problem. Refer to Soil and Water Management Module 2 (#4481-2) for more information.

Fertilizer Recommendations and Grade

Soil test results may include a fertilizer recommendation, though out-of-state labs often do not use Montana guidelines. In addition, some laboratories that specialize in agricultural soil testing will not provide a recommendation for a garden. You can use Tables 2 (N), 3 (P), or 4 (K), combined with Table 6 to determine your own fertilizer needs or you can contact your local Extension agent for specific recommendations.

The recommended nutrient rates shown on a soil test report are for the actual amount of nutrient, not the amount of fertilizer. To determine fertilizer amounts, you will need to know the fertilizer "grade". Again, grade equates to the percentage of total N, available P (in the form of P_2O_5) and soluble K (in the form of K_2O) present. If a significant source of a particular nutrient, other than N, P or K, is in the fertilizer, it is typically labeled as a fourth value. This is most often seen with fertilizers containing S (e.g., 21-0-0-24(S)). In many cases, when you have sufficient levels of P and K, your garden may still require N. Because blended garden fertilizers rarely contain only N, in this case, you should simply choose the blended bag of fertilizer with the least amount of P and K (see Table 6), or buy the cheapest fertilizer per pound of N. See sidebar for some useful measures.

Unlike agricultural fertilizers, garden fertilizers often are coated to release nutrients slowly over the growing season ("slow-release" fertilizers). Slow-release fertilizers should result in less leaching of nutrients, especially N.

Nutrient Classes

Your soil test results will typically indicate whether a nutrient level is low, medium (moderate) or high (adequate). These levels are known as "nutrient classes", or categories, and some labs may break these classes down further to very low, low, medium, high and very high. The cutoff between a medium and high level is sometimes referred to as a 'critical level' and provides a value that indicates when fertilizer should (below critical level) or should not (above critical level) be added. See Table 5 to compare your soil test results with MSU's nutrient classes.

SOME USEFUL MEASURES:

3 tablespoons (level) = 1 ounce (liquids)

8 ounce = 1 cup (liquids)

2 cups = 1 pint (liquids)

1 pint = 1 pound of most dried fertilizers

SOIL ANALYSIS CONVERSION (ppm to lb/acre)

Example:	Depth	NO_3-N (nitrate expressed as N in ppm)
	0 – 6 inch	6 ppm (from soil test report)

N in 0 – 6 inch increment Calculation:

N (lb/acre) = Soil N Concentration (ppm) x 2
= (6 x 2) **= 12 lb N/acre**

Soil Analysis Conversion

Laboratories report some nutrients in parts per million (ppm), and generally, will convert results from ppm to pounds per acre (lb/acre) for mobile nutrients, such as N and S. However, if your soil sampling depth was not provided, this conversion cannot be made. To determine N application rates, soil N results reported in ppm will need to be converted to lb N/acre. See "Soil Analysis Conversion" sidebar for an example conversion.

Conclusion

By using this guide to help you interpret your soil test report, you can gain a better understanding of the soil fertility status of your garden. This understanding should allow you to adjust your fertilizer applications to optimize plant growth and reduce fertilizer costs. If you still have questions regarding your soil test report after reading this document, please contact your local Extension agent.

References

Jacobsen J., S. Lorbeer, B. Schaff and C. Jones. 2002. *Variation in soil fertility test results from selected Northern Great Plains laboratories*. Communications in Soil Science and Plant Analysis. 33 (3&4): 303-319.

Marx, E., J. Hart and R. Stevens. 1999. *Soil Test Interpretation Guide*. Oregon State University Extension Service Publication EC 1478.

Miller, P.R.., R.E. Engel and J.A. Holmes. 2006. *Cropping sequence effect of pea and pea management on spring wheat in the Northern Great Plains*. Agronomy Journal. 98: 1610-1619.

Moore-Gough, C., R. Gough and T. Dougher. 2006. *Successful Lawns*. Montana State University Extension Service Publication MT199310AG.

Neuman, D. Reclamation Research Group. Bozeman, MT.

PPI (Potash and Phosphate Institute). 2005. *Soil Test Levels in North America, 2005, Summary Update*. PPI/PPIC/FAR Technical Bulletin. International Plant Nutrition Institute (IPNI). Norcross, GA.

Westerman, R. (ed.). 1990. *Soil Testing and Plant Analysis*, 3rd Edition. Soil Science Society of America Book Series No. 3. SSSA, Madison, WI.

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Extension Materials

Fertilizer Guidelines for Montana Crops (EB161), single copy free. http://www.montana.edu/wwwpb/pubs/eb161.html

Growing Tomatoes in Montana (MT199217AG). Free. http://www.montana.edu/wwwpb/pubs/MT199217AG.pdf

Montana Master Gardener Handbook (2004 ED). $35.00. http://gardenguide.montana.edu/newpublications.html

Nutrient Management Modules (#4449-1 to 4449-15). Free. http://landresources.montana.edu/nm

Soil and Water Management Modules (#4481-1 to 4481-5). Free. http://landresources.montana.edu/swm

Soil, Plant, and Water Analytical Laboratories for Montana Agriculture (EB150), single copy free.

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email: orderpubs@montana.edu
online: http://www.montana.edu/publications

Appendix

SOIL, PLANT AND WATER ANALYTICAL LABORATORIES: *(italicized give Montana recommendations):*

A & L Western Agricultural Laboratories
1311 Woodland Ave, #1
Modesto, California 95351
209-529-4080

Agvise Laboratories
604 HWY 15
Northwood, North Dakota 58267-0510
701-587-6010

AgSource Harris Laboratories
300 Speedway Circle
Lincoln, Nebraska 68502
402-476-0300

B &C Ag Consultants
P.O. Box 1184 (mail)
Billings, Montana 59107
315 South 26th Street (freight)
Billings, MT 59101
406-259-5779

Energy Laboratories, Inc.
P.O. Box 30916
Billings, Montana 59107
406-252-6325
800-735-4489

Midwest Laboratories, Inc.
13611 B Street
Omaha, Nebraska 68144
402-334-7770

MSE Laboratory
200 Technology Way
Butte, Montana 59701
406-494-7334

Soil Testing Laboratory
103 Waldron Hall
Bolley Drive
North Dakota State University
Fargo, North Dakota 58105-5575
701-231-8942
(please do not send payment with sample; will send bill later)

Soiltest Farm Consultants, Inc.
2925 Driggs Drive
Moses Lake, Washington 98837
509-765-1622
800-764-1622

Stukenholtz Laboratory, Inc.
P.O. Box 353 (mail)
Twin Falls, ID 83303
2924 Addison Avenue East (freight)
Twin Falls, Idaho 83301
208-734-3050
800-759-3050

Note: There are likely other laboratories in the Northern Great Plains that can meet your analytical needs.

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