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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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THIS GUIDE PROVIDES HOME GARDENERS AND Extension agents the tools to better understand and interpret soil test reports. This understanding should help the reader accurately determine fertilizer rates and the need for soil amendments, such as compost. The data in soil test 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

Due to time and the cost of soil analysis ($20-$50) compared to the cost of fertilizer for a small yard area, many gardeners do not soil test but instead use standard fertilizer rates (Table 1, 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 are not thriving or producing well, 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 your plants and the environment.

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

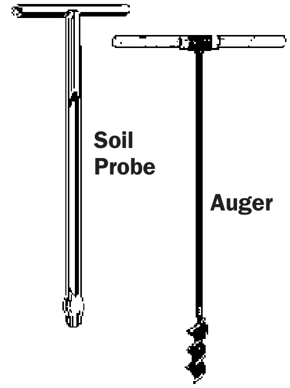

FIGURE 1. Soil sampling hand probe and auger.

Soil Sampling

To obtain meaningful and accurate soil test results, it is important that you correctly collect soil samples from multiple locations within your yard and garden. A minimum of ten samples should be collected and mixed from your garden, or from each 1,000 square feet (sq ft) of lawn to obtain a representative sample. 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 mid-summer or fall, it is best to wait at least two months after fertilization to give the fertilizer a chance to dissolve, disperse and be used by plants.

Soil samples are best collected using hand probes or augers (Figure 1). 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 with these tools, possibly biasing results. Hand augers are useful, especially when sampling at different depths. Many Extension offices have hand probes or augers and may either lend you the tools or assist you in soil sampling. An alternative tool to collect a 0 to 6 inch soil sample is a bulb planter (available at most gardening stores). Tools should be cleaned between each garden or area sampled and stored away from fertilizers to prevent contamination.

Sampling Depth and Time

For home gardens, lawns and trees, soil samples are generally a 6 inch deep core from the soil surface. In some cases, soil samples may also 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 can be collected and analyzed for these nutrients.

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

Location	Total Amount	Amount per Application	Notes
Lawns	3 lb N per 1000 sq ft per year	1 lb N per 1000 sq ft	Apply Memorial Day, Labor Day and Columbus Day
Gardens	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]
Trees/ Shrubs	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

You should schedule soil sampling to allow adequate time for soil analysis (~one to two weeks) and fertilizer application, if needed, prior to seeding or planting time. Also, soil tests are representative of current nutrient levels and do not necessarily reflect future conditions. Therefore, soils are ideally sampled yearly in the spring to best estimate growing season nutrient availability; however, it may be more practical to test soil in the fall when soil is dry and there are fewer time constraints. Unfortunately, fall samples do not always represent the true amount of N that will be available at spring planting, because some N is released from organic matter (O.M.) during the winter months in a process called 'mineralization'. Conversely, soil nitrate can be lost to leaching during wet winters, especially in shallow or sandy soils. Fall N levels will be similar to spring N levels if the fall and winter are cold and dry, because both conditions reduce N mineralization and leaching. Contact your local Extension agent for more information on soil sampling or refer to MSU Extension's *Nutrient Management Module 1 (#4449-1).*

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) or Agricultural Laboratory Proficiency Program (ALP) should provide you with analysis results of 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 best to send soil samples to the same laboratory each time to ensure consistency. Regional analytical laboratories are listed in the Appendix.

Some laboratories have standard packages that test for common nutrients and other soil parameters. At a minimum, have your soil tested for N, phosphorus (P), potassium (K), O.M., soluble salts and pH.

Tissue Analysis

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 fertilizer is applied. Therefore, it is recommended that you identify potential nutrient deficiencies by soil testing prior to the growing season. If you decide to tissue test, please contact your local Extension agent for specific information on tissue sampling and sample preparation.

Some nutrient deficiencies can be detected by observing plant growth (Table 2 and *Nutrient Management Module 9* for an expanded deficiency key). However, plant symptoms are not always consistent and can be caused by a combination of nutrient shortages. Beware of pseudo-deficiencies caused by herbicides, disease, insects, salinity, or moisture stress that look like nutrient deficiency symptoms.

TABLE 2. Plant symptoms that indicate potential nutrient deficiencies.

Nutrient	Appearance	Location on Plant	Plant Stature
Calcium	Dark green and distorted leaves, leaf tips dry and brittle	Young leaves	Blossom end rot in tomatoes[a] and peppers, tip burn in cabbage, weak stems, poor germination
Iron	Sharp distinction between green veins and yellow between veins	Upper, new leaves	Stunted under severe deficiency
Nitrogen	Yellow	Low, older leaves	Small leaves
Phosphorus	Dark green to purple, mottled or bronze as mature	Low, older leaves, stems and veins, especially on underside	Young leaves unusually small, possible very thin stems, or very lush and healthy but no flowers/ fruit
Potassium	Grey-green, mottled, yellow, scorched leaf edge	Low, older leaves	Plant wilted, stunted, lacking vigor, small misshapen fruit
Sulfur	Light green to yellow	Upper, new leaves	Small thin stems, delayed maturity

[a] Refer to the MSU Extension Montguide *Growing Tomatoes in Montana* (MT199217AG) for more information on blossom end rot.

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. Soil test results may include a fertilizer recommendation, though they may not be based on Montana guidelines or are for agricultural rather than home vegetable garden production. Guidelines shown in this document are for the entire state of Montana and they may need to be adjusted for your location. For example, if you are in a warmer location, you may 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 than optimal water, you should reduce your fertilizer rates.

One season's harvest of the edible portion of garden vegetables removes on average 2-3 lbs N, 0.5 lbs P_2O_5, and 3 lb K_2O per 1000 sq. ft. of garden.

(Morris et al. 2007)

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. Once soil nutrients are brought up to high or critical levels, whether with conventional fertilizer or organic material, only enough nutrients need to be added annually to replace those lost to leaching or removed by harvest (see text box above). Ideally you should soil test every few years to monitor your fertility management.

Macronutrients

Macronutrients that may be tested in your soil include N, P, K, sulfur (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; however, artificial Ca deficiency may develop with water stress.

Nitrogen

Soil tests generally measure nitrate-N because it is the best indicator of plant available N, and report N in pounds per acre (lb N/acre) or parts per million (ppm). For the remainder of the document, nitrate-N will be referred to as N.

Nitrogen guidelines based on soil test levels and O.M. are given in Table 3 on the following page. The section "Fertilizer Grade and Rate Calculations" explains the calculation of actual fertilizer application rates. If you are using a fall soil sample, then rates may need to be adjusted because available N can change over winter. If fall nitrate levels are low (<10 lb N/acre or <5 ppm in upper 6 inches), then leaching loss is not a big concern. If they are high (>40 lb N/ac or >20 ppm), then there could be substantial leaching in a wet fall/winter. If O.M. is high (>5%), then N will likely increase from fall to spring due to N release from the O.M. Basing spring fertilization rates on a fall soil test in a wet year could lead to under fertilization, whereas in a dry year a fall soil test could lead to over fertilization.

Soil N can be increased by growing legumes (beans, peas). Rotating these N-fixing plants with heavy feeders (broccoli, corn, lettuce, potatoes) can help manage soil N and ensure efficient nutrient use throughout the garden.

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		

TABLE 3. Nitrogen fertilizer guidelines based on soil test results and organic matter level. Soil nutrient class for N is plant dependent.

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
	Gardens	4	3	3
20 – 40	Lawns	4	3	2
	Trees/Shrubs[b]	2	1	1
	Gardens	2	2	2
40 – 80	Lawns	2	1	1
	Trees/Shrubs[b]	1	0.5	0
	Gardens	1	1	0.5
> 80	All	0	0	0

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

Phosphorus and Potassium

Unlike N, P is highly immobile in the soil and in most Montana soils high levels of Ca tie up P, making it relatively unavailable to plants. Montana has among the lowest soil test P levels in the country (PPI, 2005). There are three major soil tests used for available P: the Bray-1 and Mehlich-3 tests for acidic soils, and the Olsen P test 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. Olsen P is fairly robust and works well at pH above and below 7. Bray, however, does not work well at pH levels higher than 7.

Potassium is also immobile in the soil, though not as immobile as P. Potassium soil tests will be lower in late summer than early spring, because plants will have removed K from solution and from the edges of soil particles. The highest and most accurate K levels will be measured in the spring just after the soil thaws and before plant uptake becomes substantial. Plants can continuously absorb K beyond their 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 4 and 5 for recommended P and K fertilizer guidelines.

Sulfur

In many Montana soils, responses to S fertilizer are much less consistent than for P and K, partly because available S below 6 inches 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 which generally contain little gypsum and do not retain S well. The best way to determine if your plants are S deficient is to look for uniform yellowing on the youngest leaves (Table 2). If S is needed, an application of 0.3 to 0.5 lb of S/1000 sq ft is recommended.

Micronutrients

Mineral micronutrients are naturally present in the soil and required by plants in lower quantities than macronutrients, yet are no less important. They include boron (B), chloride (Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), nickel (Ni) and zinc (Zn). Because micronutrient deficiencies are uncommon, there has been little work in Montana to determine plant-specific micronutrient requirements. However, some plants are more prone to micronutrient deficiencies than others. For example, Fe deficiencies are very common in members of the Rose family, as well as ash, apple, crabapple and some maple trees.

In general, Ni and Mo are more than adequate in Montana soils and will not be discussed further. Table 6 lists soil nutrient classes based on nutrient concentrations (ppm) for Montana soils. Apply 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') rather than on the soil surface, because metals are very immobile in the soil. Micronutrients should not be added unless indicated by a soil test, as excess can be detrimental.

TABLE 4. Phosphorus nutrient class and fertilizer guidelines based on soil tests.

Olsen P[a]	Nutrient Class	Gardens	Lawns	Trees/Shrubs
ppm		·····lb P_2O_5/1000 sq ft ·····		
< 4	Very Low	5	3	3
4 – 8	Low	4	2	2
8 – 12	Medium Low	3	1	1.5
12 – 16	Medium	2	0	1
16 – 30	High	1	0	0
>30	Very High	0	0	0

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

TABLE 5. Potassium nutrient class and fertilizer guidelines based on soil tests.

Soil test K[a]	Nutrient Class	Gardens	Lawns	Trees/Shrubs
ppm		·····lb K_2O/1000 sq ft ·····		
< 75	Very Low	3	4	2
75 – 150	Low	2	3	1
150 – 250	Medium	1	2	0.5
250 – 500	High	0	1	0
>500[b]	Very High	0	0	0

[a]Ammonium acetate extractable K, 0-6 inch sample depth
[b]Levels above 800ppm can lead to toxicity (Marx et al. 1999)

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 < 20 lb N/acre: 3 lb N/1000 sq ft (Table 3)

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**
This is adequate for soils low in P, but too much for soils with >8 ppm Olsen P (Table 4), for which you should select a fertilizer with less P.

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**
This is adequate for soils very low in K, but too much for soils with >75 ppm K (Table 5), for which you should select a fertilizer with less K.

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

Organic Matter

Soil O.M. consists of partially decomposed plant (and animal) material, such as roots, grass clippings and tree leaves. A 5 to 8% O. M. content is considered suitable for soil tilth, water holding capacity, and reduced erosion potential. Garden soil O.M. is often at least this high from additions of compost or manure. The source of organic material being added influences the amount of O.M. being added to the soil. Composted manure may be around 20% O.M., whereas plant compost is around 80% O.M. A one-time addition of three inches of manure compost, worked into the top 6 inches of soil can increase O.M. content by about 5%, while three inches of plant compost could increase soil O.M. by 20%. For example, if your garden soil has 2% O.M. and you work two tons of manure compost into 1000 sq ft of garden space (about three inches), the top 6 inches will then be about 7% O.M. Keep in mind, these are all approximations because compost varies widely in its composition. You may want to have your compost tested for O.M. and nutrients before adding it to your garden.

Organic material high in carbon (C) and low in N (high C:N), such as bark mulch, wood shavings, straw or corn stalks, may cause an N deficiency as the microbes responsible for decomposition use the available soil N. To avoid a possible N deficiency with high C:N organic material (meaning C:N greater than 40:1), add about 24 pounds of actual N for each ton of organic material added. See the section on "Fertilizer Grade and Rate Calculations", and the Calculation Box for help with application rate calculations.

It is possible to add too much organic material, especially manure, leading to a nutrient imbalance, and possible water contamination. Generally, manure has high levels of N, and higher proportions of P and K relative to N than needed by plants. Therefore, large amounts of manure may result in excessive levels of P and K. Periodic soil tests are important to track O.M., N, P, and K. If your soil O.M. content is over 9% and your soil has cracks shortly after watering (indicating excessive clay), adding sand rather than more organic material should help aerate the soil, improving tilth and garden production.

Soil pH

Soil pH is a measure of soil acidity or alkalinity. The pH scale ranges from 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 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.

In eastern Montana, surface soil pH is typically between 7 and 8, while western Montana soils tend to be slightly more acidic. Maximum availability of N, P, K and S occurs at pH 6.5 to 8 and at pH 5 to 7 for most micronutrients. Soil pH outside of optimal ranges may cause nutrients to be

TABLE 6. Soil nutrient classes and toxicity levels for some micronutrients. These are all for soil collected in the 0 – 6 inch soil depth.

Nutrient	Nutrient Class			Toxicity Levels
	Low Levels	Medium Levels	High Levels[a]	
	··········ppm··········			
Boron (B)	< 0.5	0.5 – 1.0	> 1.0	5[b]
Chloride (Cl)	NA[c]	NA	NA	NA
Copper (Cu)	< 0.25	0.25 – 0.5	> 0.5	NA
Iron (Fe)	< 2.5	2.5 – 5.0	> 5.0	NA
Manganese (Mn)	< 0.5	0.5 – 1.0	> 1.0	NA
Zinc (Zn)	< 0.25	0.25 – 0.5	> 0.5	60[d]

[a]Comparable to critical levels [b]Westerman (1990) [c]NA – not available [d]Neuman, pers.comm.

TABLE 7. 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·····**		
5–10–10	20	40	60	10	20	30	10	20	30
8–5–5	13	25	30	20	40	60	20	40	60
17–17–17	6	12	18	6	12	18	6	12	18
20–20–20	5	10	15	5	10	15	5	10	15
30–3–3	3	7	10	33	67	100	33	67	20

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. Addition of elemental S is the most common strategy, but rates near 225 lb S/1000 sq ft have been found to only lower pH from 7.9 to 7.5 (Agvise Laboratories, ND). Additions of O.M. may lower soil pH over time; however, not all O.M. sources are effective. Many manure sources within Montana and Wyoming are alkaline ('they are what they eat') and may not 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.

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. Though some plants are more tolerant to salts than others, EC values higher than 4 may damage plants. The units are either 'millimhos per centimeter' (mmhos/cm) or 'deci-Siemens per meter' (dS/m). Soluble salt levels will be lower following substantial amounts of rain or irrigation; therefore, sampling should be done during a drier period. Certain fertilizers, amendments, and manure can contribute to salt accumulation in localized areas. Refer to *Soil and Water Management Module 2* and *Nutrient Management Module 10 and 13* for more information.

Fertilizer Grade and Rate Calculations

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'. Grade (the three numbers on a fertilizer bag) is the percent of total N, available P (in the form of P_2O_5) and soluble K (in the form of K_2O) in the fertilizer. For example, if a fertilizer is labeled 30-10-10, it contains 30% N, 10% P (as P_2O_5) and 10% K (as K_2O). If a fertilizer contains a significant source of an additional nutrient, other than N, P, or K, it is typically labeled as a fourth value. This is most often seen with fertilizers containing S (e.g., 21-0-0-24(S)).

The amount of fertilizer needed to apply specific rates of actual N, P, and K is presented in Table 7 for a few common fertilizer grades. For other grades, see the Calculation Box (page 5) for an example of how to determine fertilizer rates based on a soil test report (Figure 2) and fertilizer guidelines (Tables 3, 4 and 5). In many cases, when you have sufficient levels of P and K, your garden may still require N. If you are unable to locate a fertilizer containing only N, choose a grade with the least amount of P and K, or the cheapest fertilizer per pound of N. See below for some useful measures.

Unlike agricultural fertilizers, garden fertilizers often are coated to release nutrients slowly over the growing season ('slow-release' fertilizers). These should have grade ratings and the calculations for application rates are the same as for conventional fertilizers. However, the release of the nutrients is slower, and they must be applied early in the growing season. Slow-release fertilizers should result in less leaching of nutrients, especially N.

SOIL ANALYSIS CONVERSION (ppm to lb/acre)

Example: A test report states NO_3-N (nitrate) is 6 ppm in the top 0-6 inches of soil.

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

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

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 (page 6) 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 help you 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

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Extension Materials

MSU Extension publishes a variety of materials regarding fertilizers that may be helpful.

Fertilizer Guidelines for Montana Crops (EB161). Free. http://msuextension.org/store/Products/Fertilizer-Guidelines-for-Montana-Crops__EB0161.aspx

Successful Lawns (MT199310AG). Free. http://msuextension.org/publications/YardandGarden/MT199310AG.pdf

Montana Master Gardener Handbook (2012 ED). $50.00. http://msuextension.org/store/Products/Master-Gardeners-Handbook__EB0185.aspx

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). Free. http://msuextension.org/publications/AgandNaturalResources/EB0150.pdf

You may request these publications and many others, from your local county Extension agent or by contacting Extension Publications at the address below. A shipping and handling fee will be charged.

MSU Extension Publications
P.O. Box 172040
Bozeman, MT 59717-2040
(406) 994-3273
email: orderpubs@montana.edu
online: http://www.msuextension.org/store

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Appendix

SOIL, PLANT AND WATER ANALYTICAL LABORATORIES (most provide recommendations based on regional published guidelines, italicized laboratories offer recommendations based on MSU fertilizer guidelines)

A & L Western Agricultural Laboratories
1311 Woodland Ave, #1
Modesto, CA 95351
209-529-4080
www.al-labs-west.com

AgSource-Harris Laboratories
300 Speedway Circle
Lincoln, NE 68502
402-476-0300
http://agsource.crinet.com/page3777/LincolnNeb

Agvise Laboratories
604 Hwy 15 W
P.O. Box 510
Northwood, ND 58267-0510
701-587-6010
www.agvise.com

B&C Ag Consultants
315 South 26th Street
Billings, MT 59107
406-259-5779
www.bncag.com

Energy Laboratories, Inc./Fehringer Agricultural Consulting
1120 South 27th St.
Billings, MT 59101
406-252-6325
800-735-4489
www.energylab.com

Midwest Laboratories, Inc.
13611 B Street
Omaha, NE 68144
402-334-7770
www.midwestlabs.com

Sathe Analytical Laboratory, Inc.
301 2nd St W
Williston, ND 58801
701-572-3632

Soil Testing Laboratory
103 Waldron Hall
Dept. 7680, P.O. Box 6050
North Dakota State University
Fargo, ND 58108
701-231-8942
https://www.ndsu.edu/soils/services/soil_testing_lab/

Soiltest Farm Consultants, Inc.
2925 Driggs Drive
Moses Lake, WA 98837
509-765-1622
800-764-1622
www.soiltestlab.com

Stukenholtz Laboratory, Inc,
P.O. Box 353
2924 Addison Avenue East
Twin Falls, ID 83303
208-734-3050
800-759-3050
www.stukenholtz.com

University of Idaho, Analytical Sciences Laboratory
Holm Research Center
2222 W. Sixth St.
Moscow, ID 83844-2203
208-885-7900
http://www.uidaho.edu/cals/analytical-sciences-laboratory
(does not provide interpretation or recommendations)

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

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File under: Yard and Garden (General)
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